THE GLASS INDUSTRY
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THE EAST GETS A NEW GLASS FACTORY

THE METRO Glass Bottle Co., the newest member of the Knox Glass Associates, Inc., after nearly six months of preliminary work during which time the company was organized, suitable property purchased, the plant constructed and an efficient personnel built up, is now in full production and is turning out excellent quality ware. The remarkable speed shown by the engineering staff in building this plant is a credit to the Knox organization.

The new plant is located on a plot of two acres situated on the outskirts of Jersey City within 15 minutes trucking distance from the Holland Tunnel and is also located on the main line of the Central Railroad of New Jersey. While all of the raw materials are being received by rail, the finished product is being distributed in the Metropolitan area of New York City by the means of a fleet of ten five-ton trucks. At present the output of the plant consists exclusively of a line of high class liquor and beverage bottles, the sale of which is made solely to Glickstein and Tener, Inc., of Brooklyn, N. Y.

The plant (Fig. I) consists of a series of interlocking steel buildings housing the furnace, hot end, packing room, power plant, mold shop, batch room and storage under more or less a single roof. The compact arrangement of the entire plant is the work of H. C. Ganter, chief engineer of Knox Glass who supervised the designing and erection of all of the buildings as well as the installation of the machinery and the furnace.

The melting furnace (Fig. II) was designed by B. F. Morton of Blaunox, Pa., and is of the end port, regenerative type providing for a daily drawing capacity of 60 to 70 tons and melting on an area of about 5 square feet at a bridgewall temperature of 2650° F. Laclede-Christy refractories were used throughout the tank with the exception of the bridge, throat and doghouse which are built of Corhart. The furnace is fired with Socony Bunker "B" fuel oil of 16-18° Be gravity. Oil system was installed by E. S. Hammond, Inc., Bloomfield, N. J.

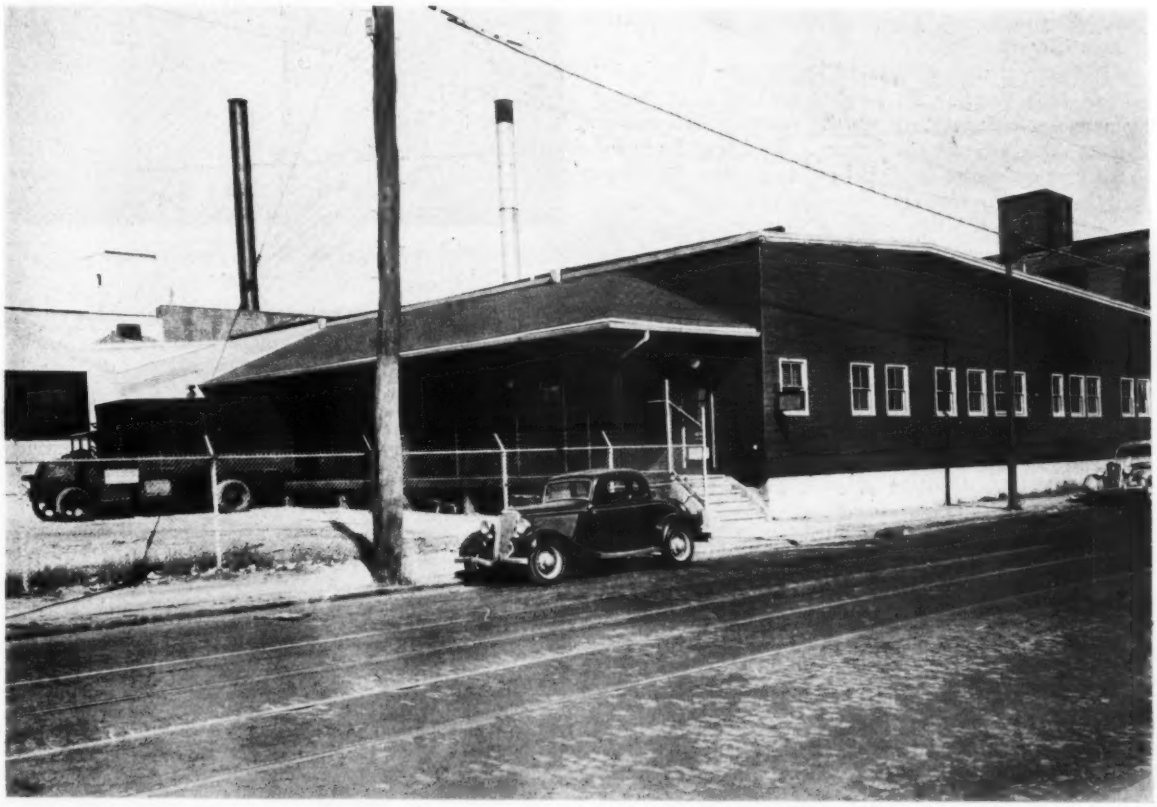

Fig. 1. The Metro Glass Bottle Company's plant in Jersey City, N. J., as seen from the front.

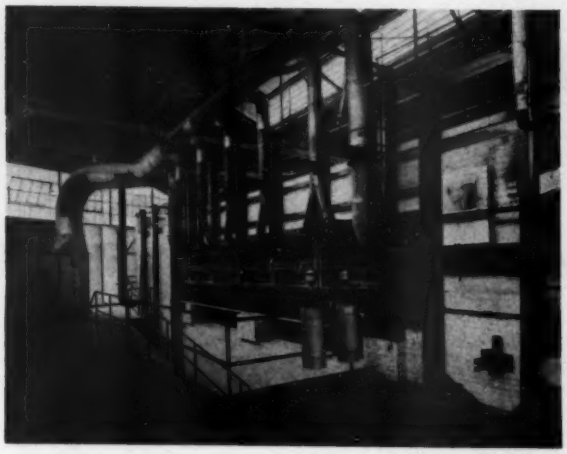

Fig. 2. The 75-ton regenerative furnace.

In the hot end of the plant (Fig. III), four Miller type feeders supply glass to the following forming machines: Knox O'Neil, Lynch 10, 44 O'Neil, and 42 O'Neil. Ware from these machines is conveyed to two Knox type bottom-fired muffle lehrs. Both feeders and lehrs are fired with manufactured gas supplied by the Public Service Gas and Electric Co. of New Jersey.

The batch used is the usual soda-lime-silica type container batch. The raw materials for the batch are being supplied by the following firms: Sand—Pennsylvania Glass Sand Co.; soda ash—Columbia Alkali Corporation; lime—Kelley Island Lime and Transport Co.; feldspar—Consolidated Feldspar Corp.; barium—National Pigments and Chemical Co.; cullet—American Broken Glass Co.

All raw materials are stored in concrete bins in the mixing room. After the batch is mixed, it is carried by a bucket elevator to a gravity system which carries it to the doghouse of the furnace. It is then hand fed to the furnace, cullet being fed in separately. Excellent quality and color flint glass is being produced.

The mold shop while small is quite complete, compact and well equipped. At present the bulk of the mold work concerns repair work but in the future new mold equipment will also be handled in this shop.

Adjacent to the mold shop is the power plant which houses two compressors, one of 50 H. P. and the other of 200 H. P. in addition to a vacuum pump which is used only for the Lynch and Knox O'Neil machines. The simplicity of the power plant is due to the fact that it is entirely electrically driven. A very small boiler being all that is required to meet the steam requirements of the entire plant.

In the packing room (Fig. V) a novel arrangement, the basis of which again concerns compactness, is being used. Directly overhead of the discharge end of the lehrs is the carton assembly department. The cartons after being formed and stitched are then fed to the packers below by means of a wide chute. As the carton department is in full view of the packer, excellent cooperation of the two results. From the packing tables the ware can be transferred either directly to the shipping platform or to the storage shed.

At present the Metro plant is employing approximately 160 persons.

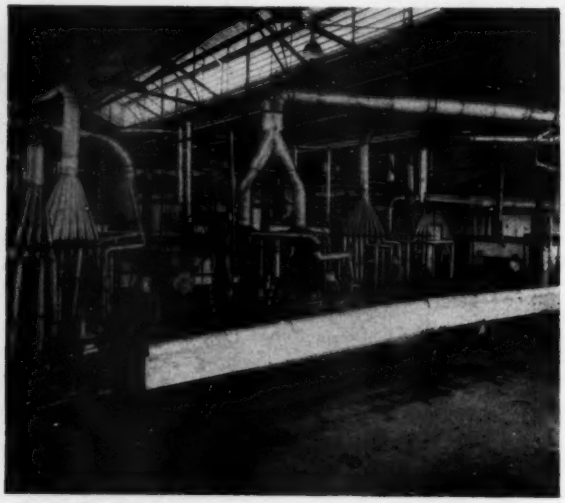

Fig. 3. Hot end showing machines, conveyors and lehrs.

Fig. 4. Power plant and mold storage.

Fig. 5. Packing tables and carton department.

INFLUENCE OF MELTING TIME ON THE IRON OXIDE CONTENT OF GLASSES

By FRANZ BAUER[1]

IF ONE reads the literature concerning decolorization of glass, he always encounters the assertion that long melting periods evaporate part of the decolorizing agent so that decolorization is no longer complete and the green color again prevails. Analytically it is very difficult, indeed often impossible, to separate and accurately determine the small amount of material used to decolorize, since the limits of error of the analytical methods are greater than the traces of decolorizer which has evaporated. Recent scientific work has shown that all materials used in making glass will volatilize more or less during the melt. This, of course, includes the decolorizer.

This article will discuss another important point; namely, the increase of iron oxide content in the glass in relation to melting time. It is generally known that the clay used in making glass pots contains more or less iron. In fact, the best clay contains between 1.3 and 2.5 per cent iron oxide. Attempts to reduce the iron content of the clay have so far led to no results since the bond suffers thereby and the finished pots either break or bulge in service. The melting and molten glass strongly attacks the pots and dissolves relatively large quantities of iron so that with prolonged melting time the decolorizer is no longer sufficient.

For this test, two different glasses were melted. Glass designated as I consisted of about 75 per cent SiO_2, the balance was B_2O_3, Na_2O, and K_2O. Glass designated as II had in addition an Al_2O_3 content of about 4 per cent. The test melts were made in 50 kg. crucibles placed in the furnace. Samples were taken during the melt and the iron oxide determined. The tests from glass I were taken as follows:

1. Shortly after cleaning when only a few large bubbles remained.
2. 1½ hours later.
3. 4 hours after the first sample.

In glass II:

1. Same as above.
2. 1 hour later.
3. 1½ hours after first sample.
4. 7 hours after first sample.

The analyses were carried out as follows: 1.000 g. of glass powder (ground in an agate mortar) was decomposed with 30 cc. HF and several drops of sulfuric acid in a platinum dish; taken up with 30 cc. HCl, 1:1, and oxidized in a beaker with several drops of HNO_3. The iron was determined colorimetrically. As a comparison, a Mohr's salt solution was used which contained 0.35 g. per liter corresponding to 0.1431 mg. iron oxide per cc.

The values found for the glass samples were as follows:

Glass I—Sample 1—0.0146% Fe_2O_3
2—0.0137
3—0.0203

Glass II—Sample 1—0.0480% Fe_2O_3
2—0.0470
3—0.0480
4—0.0500

Most striking is the fact that glass II did not take up any more iron. The small variations can be in the analysis since the results lie within the limits of experimental error. The stability of glass II is probably due to the 4 per cent Al_2O_3 content. The glass is saturated with Al_2O_3 and the melted glass, at least, attacks the pots little if any.

Glass I, on the other hand, shows us that the finished glass is in a position to strongly attack the pots. The iron oxide content increases about 50 per cent. It is now clear why decolorization calculated for the normal iron oxide content is no longer sufficient. It is a well known fact that color is not all that could be desired after the Sunday shut down. Many factories, especially crystal glass plants melt on Sunday for Monday operation in order to avoid letting the glass stand. Of course, the temperature is an important factor. In this case, during the melt it was about 1480°C. Intentional additions of alumina to a pure colorless glass will probably stabilize it. Alumina can now be introduced in the form of aluminum hydrate and, in the quantities needed, cause no difficulties.

In the course of the research another interesting fact was established. The tests were always made in duplicate in two crucibles of the same size and from the same firm. Identical batches were added at the same time. The crucibles stood in the furnace in such a way that it could be assumed that each had the same temperature. Nevertheless, the iron content of the same melts were fundamentally different.

	Left Crucible		Right Crucible
Glass I	0.026%	Fe_2O_3	0.0146%
Glass II	0.065%	Fe_2O_3	0.0480%

It is a well known fact that when 10 pots are in a furnace one or another requires a special dose of decolorizer. A cold or hot spot in the furnace or a different furnace atmosphere is usually blamed. The figures show, however, that in two equal glasses different iron content resulted due to different rates of attack on the pots.

The amount of solution is also closely related to the composition of the glass batch. This is most clearly shown in the work of Bartsch[2]. If these results cannot be taken over into practice 100 per cent, still they show that every mix has a different resistance to attack. However, the tests described should be considered only as a feeler.

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[*] Translated by Dr. Samuel Scholes.
[1] Glashütte 65, 308-309 (1935).
[2] Glastechn. Ber. 1926—Heft. 7.

MOVEMENTS OF GLASS MEN

Joe Gregorius, vice chairman of the Glass Division of the American Ceramic Society, is in Europe on behalf of the Pittsburgh Plate Glass Company. When in this country, his headquarters are at the No. 1 plant of the company, viz., at Creighton, Pa., on the Allegheny River not far from Pittsburgh. Illustrated is an aerial view of the plant. This, of course, is in the same area depicted in The GLASS INDUSTRY for November 1934, entitled the cradle of the plate glass industry in America.

In the photograph the main mass of long buildings parallel to the river contain the furnaces, and the grinding and polishing equipment for "continuous" plate glass. The tall building nearest the observer is reputed to be the Duplate plant, making laminated safety glass from the material supplied by the polishers. The road in front of this, going down to the river passes first in front of the main offices of the plant (the small square building) and then in front of the research department near the river. In the former may usually be found Mr. W. Barnes (when he isn't out in the plant) and possibly Gregorius; in the latter, Messrs. Gelstharp, Parkinson, Fulton, and many others.

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Plant of the Pittsburgh Plate Glass Company at Creighton, Pa.

At the end of the road is a high tension pylon, and another may be seen on the opposite side of the river, at the corner of vacant land belonging to the No. 1 plant of the American Window Glass Company.

The wharf sticking out into the river by the Pittsburgh Plate plant, is where the sand dredged from the river for grinding glass is unloaded. A large pile of it may be seen in the picture.

CHEMICAL PROPERTIES OF GLASS SURFACES

By G. KEPPELER, TECHNISCHE HOCHSCHULE, HANOVER

MANY experiments[1] show that glass surfaces are subject to attack by chemical agents. If a glass surface comes in contact with a liquid, those small particles lying on the surface which are soluble are dissolved by the solvent. The alkalis are dissolved by water; lime and barium by hydrochloric acid; lead oxide by nitric acid, etc. From this fact it is apparent that the durability of glass depends essentially upon its composition. These relationships between the composition and the solubility of glasses have been studied extensively, but it is difficult to correlate them.

However, if the action of water, which is the most important, is observed, the influence of a single oxide may be ascertained by the solubility of the component in water. This principle is not an absolute law but it suggests the variation of the solubility of the glasses by the molecular replacement of one oxide by another. From investigations by Heyser, Mylius and Forster, it is evident that the solubility of glasses of comparable compositions decreases according to the water solubility of the oxide; from barium glass to strontium glass to lime glass. From the work of Dimbleby and Turner it appears that glasses of the molecular composition, $6\,SiO_2 \cdot (2\text{-}x)\,Na_2O{\cdot}4RO$ or R_2O_3 or RO_2, especially in alkali-poor samples, have a solubility in boiling water as follows: BaO, CaO, MgO, ZnO and Al_2O_3 in the order of the water solubility of the oxides replacing soda. However, no numerically exact prediction of the variation of the solubility caused by a composition change can be concluded from the principle.

The effect of various constituents on the chemical durability of a series of glasses is complicated and it can be learned only by the investigations of whole systems, as Ippach, Moller and Zschimmer, Berger, Bohmert and others have done. The study of such a system shows plainly that the replacement of one oxide by another in different parts of a system acts differently. For example, the molecular replacement of soda by potash in alkali-rich alkali-lime glasses increases the solubility less than in alkali-poor glasses. Thus it is evident that the introduction of an oxide which increases the durability of a glass has a greater effect if the parent glass is more soluble. For example, if a part of the silica in a soda-lime glass is replaced by alumina; an equimolecular amount of alumina, in an already slightly soluble glass, produces much less improvement in the durability than in one of the system of imperfect glasses.

There are a number of influences which vary the solubility of a surface of similar pieces of glass. It must be borne in mind that a glass melt is not strictly homogeneous, and this can produce a difference in the surface properties.

If it is true that the development of the sorption equilibrium in the glass surface at its production demands appreciable time, then a glass developed quickly from the melt or from the piece will behave differently under similar conditions than an object formed slowly. From this conception, Rosenhain assumed that thin, mouthblown window glass is more soluble than the same glass blown into thick flasks. Since other influences enter in, it is difficult to explain the influence of the speed of formation. However, it is certain that a freely blown flask of the same mass possesses different properties than one blown in a mold, and that the inner surface of the flask blown in a mold is more soluble than the outer.

It is also assumed that every glass surface produced by cooling in acidic gases is deprived of alkali and thus has greater durability against chemical influences. Even if the process of cooling glass is beneficial, the

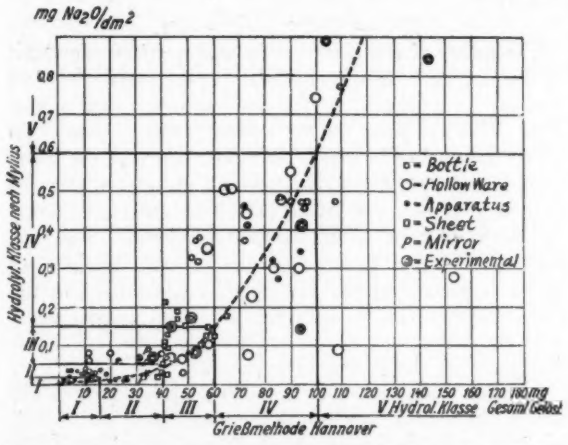
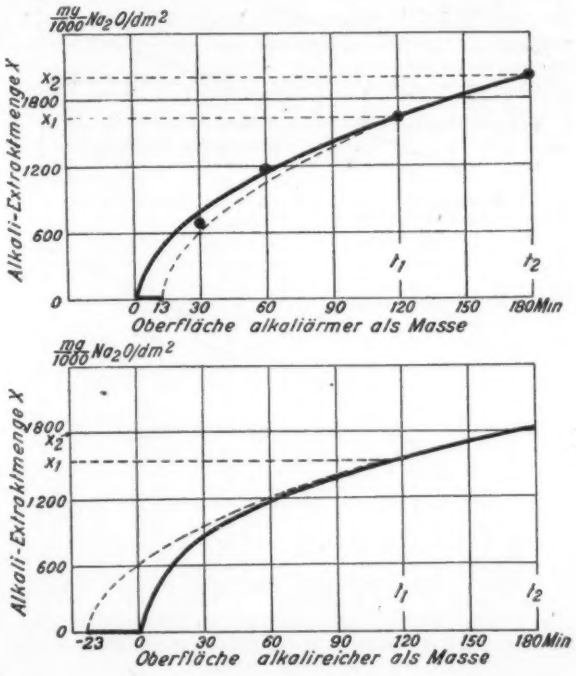


Fig. 1. (Above) Powder and surface solubility of the same glasses. Fig. 2 (Right) The influence of surface preparation on the extraction-time curve. (Above) Surface poorer in alkali than the main body. (Below) Surface richer in alkali than the main body. Experimental results shown in solid curve, external parabolas in dotted curve.



influence of heating is exactly reversed. Alkali migrates from the deepest layers to the surface and thus renders a glass soluble. But it appears that long-continued heating tends towards a maximum value of solubility corresponding to the temperature.

The causes and influences which appear to vary the chemical properties of glass surfaces become evident if the solubility of a glass obtained by the powder method is compared with the value obtained for the solubility of the forming surface. A large number of experiments which were carried out in Keppeler's laboratory are represented graphically (Fig. 1). The results of the powder method are taken as abscissae; the alkali extracted from the forming surface, as the ordinates. There is a large variation in the results for the individual glasses which shows how variable are the relations between the properties of the surface and the glass mass. However, upon these relationships depend the attempts to derive the surface solubility from the results of the powder method. The estimation of the surface solubility by this method is only approximate.

Many investigators have extended the extraction over a long period of time and the extracted amount has been determined from time to time. From these experiments it is evident that the speed of the water attack is faster, the more soluble the glass. Mylius showed that the curve, which shows the extraction value as related to the number of extractions repeated one after the other, "runs apart fan-like" for glasses of very differing classes of durability. Mylius is also emphasized because of his eosin test; but an isolated eosin test is not sufficient to characterize a glass definitely. This test should be compared with some others for a true criterion of a glass. Jebsen-Marwedel also emphasized the fact that a single extraction, obtained in a limited time, is not sufficient.

Keppeler renewed the question of the effect of time upon the extraction. If diffusion processes control the

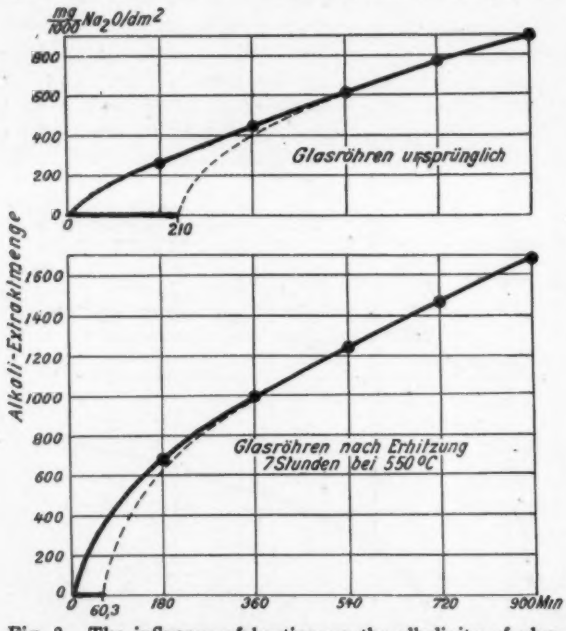


Fig. 3. The influence of heating on the alkalinity of glass surfaces. Above: original tubes. Below: tubes after heating 7 hours at 550°C.

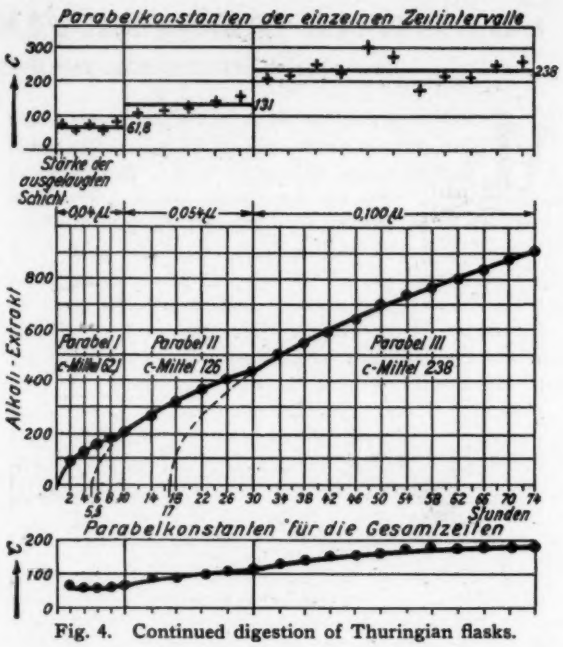


Fig. 4. Continued digestion of Thuringian flasks.

extraction, it can be supposed that the dependence of the extracted amount on the time of extraction could be represented as a parabolic function. It appears that a more precise insight into the extremely fluctuating properties of glass surfaces can be obtained with a greater number of extractions, extended over a longer time, and by a comparison of the results with the parabolic rule. The difference between the properties of the surfaces and the deepest layers is expressed by a deviation from the strict parabolic curve. Since the initial velocity of solution influences the ultimate value, it is desirable to free the final extraction value from the influences of the beginning. For this purpose a parabola which goes through two latter extraction points may be tried. Then, if X_1 and X_2 are the extraction values for the times t_1 and t_2, the following true dependence is found:

$$X^2_2 - X^2_1 = c\ (t_2 - t_1).$$

The nature of a surface can be characterized somewhat by the interval-parabola obtained. If the surface has lost any part of its alkali, the parabola proceeds with a slow rise. This is shown in the upper graph of Fig. 2 in which the surface behaves, in comparison with the inner mass, as if it had been leached 13 minutes under the conditions of the experiment, before the actual beginning of the experiment. Thus the calculated time of the experiment must be shortened by this amount. When more alkali is present in the surface of a glass than in the mass, the interval-parabola for the latter course intersects the horizontal axis a measurable time before the zero point of the measured parabola.

The lower graph of Fig. 2 shows a glass which would need to have been leached 23 minutes before the experiment in order to attain an alkali concentration on the surface corresponding to that of the deepest layers. In other words, the calculated extraction time should be lengthened about 23 minutes under similar conditions.

It has been suggested that glass surfaces which are heated for a long time show a stronger alkali extraction

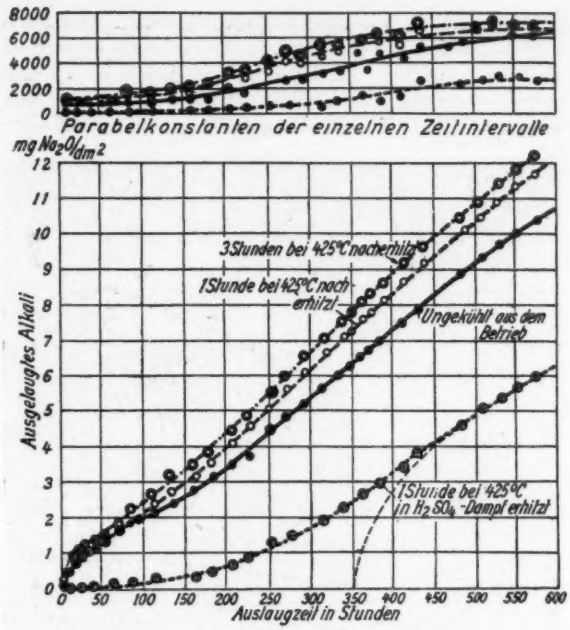

Parabelkonstanten der einzelnen Zeitintervalle
mg Na2O/dm2
3 Stunden bei 425°C nacherhitzt
1 Stunde bei 425°C nacherhitzt
Ungekühlt aus dem Betrieb
1 Stunde bei 425°C in H2SO4-Dampf erhitzt
Ausgelaugtes Alkali
Auslaugzeit in Stunden

Fig. 5. Digestion of glass flasks after various treatments.

than before the heating. Miss Heckter investigated a glass in the original and in the heated state. The results are shown in Fig. 3. The original glass tubes behave alkali-poor on the surface, as if they had already been leaching 20 minutes before the start of the experiment. The alkali concentrations of the surface and in the mass become equalized by heating. The alkali migrates to the surface and the alkali deficiency is opposite to the deepest layers so that it corresponds to an extraction of only 60 minutes.

Keppeler attempted to complete these results on Thuringian glass by a longer extraction time. He originally planned to carry out the experiments in such a way that three flasks were leached one hour, the same number of other flasks for three hours, etc. The results showed that the differences of the individual flasks were often greater than the influence of the extraction time. Therefore, he quickly cooled the three or four flasks of a series after the attainment of the extraction time, emptied the contents for investigation, and prepared the flasks, after a short rinsing, for the continuation of the experiment. A small uncertainty in the value occurs, but it is equalized by increasing the extraction time.

These results are shown in Fig. 4 in which it appears that the real glass mass is encountered after 30 hours. If the experiments were extended over a longer period of time, 600 hours or more, the initial variation measured for the entire course is blotted out and the curve acquires a more uniform character.

From experiments of long extraction time, it appears doubtful that, in the entire time, the layers of gelatinous silica which originate by the leaching, remain wholly unchanged. Probably it should be assumed that the alkali migrating through the gelatinous framework exerts some dissolving influence and thus widens the diffusion path. Berger thought that fractures and local splintering increased the speed of extraction, but Keppeler did not find any effect from this source. He also noted that the extraction for heated glasses is still greater after 600 hours (Fig. 5). Up to about 400 hours, heated flasks show a greatly increasing constant which runs beyond a common value for the heated as well as for the unheated flasks. It can be assumed that one thus approaches layers of inner equilibrium. However, this still remains doubtful because in longer continued experiments, the constants fall off again slowly. Supplementary experiments are needed in order to arrive at a definite conclusion upon this question.

Important effects are produced when the glass is heated for one hour at 425°C in H_2SO_4 vapor. The extraction time must be extended about 100 hours, for a measurable alkali value because the surface is greatly improved by the acid treatment. If the extraction value between the 500 and the 600-hour period is used for the construction of the interval-parabola, the improvement by H_2SO_4 vapor corresponds to a 350-hour leaching, according to Mylius; but it is really much greater. This will probably renew attention to the importance of the stabilizing of glass surfaces by cooling in acidic gases.

Experiments on sheet glass are equally interesting. The results of various tests are shown in Fig. 6. The sheet glass tested was produced by the Libbey-Owens process. The upper side remains longer than the lower side under the direct action of a flame, for the purpose of bending. Thus it happens that the general improving effect of SO_2-containing gases on the upper side is neutralized, and the tests show that the upper side is somewhat more soluble than the lower. For all tests it is noteworthy that in the case of longer duration of leaching the parabolic constants decrease rapidly and after 100 hours practically no more alkali extraction takes place.

For the purpose of greater clarity, four values (1. upper side, 1. lower side, 2. upper side, 2. lower side) are compiled in the middle curve. These results all point to a very peculiar structure of the Libbey-Owens glasses. If these glasses are heated for 7 hours at about 500°C, alkali migration to the surface takes place, and the solubility increases as is shown in the upper curve of Fig. 6.

An equalization in the properties of the upper and lower surfaces of the glass slabs results from heating. With glass in the original condition, the interval-para-

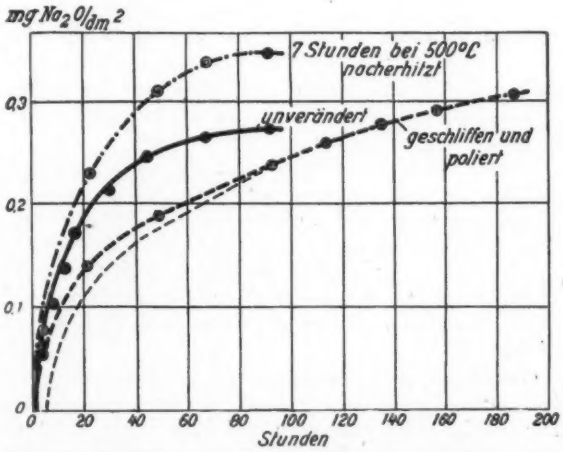


Fig. 6. Solubility of Libbey-Owens glass after various treatments.

bola constants of the upper side were found to be 54 per cent greater than the value for the lower side. The difference, however, was only 18 per cent in slabs heated at 500°C for seven hours.

The lower curve of Fig. 6 shows the effect of grinding and polishing upon the solubility of a glass. If the interval-parabola be calculated from extraction values for the 100- and the 200-hour periods, it is found that grinding and polishing produces a compensation (improvement) which corresponds to a Mylius extraction of about two hours. It is also shown that this compensating action is far behind that of H_2SO_4-containing vapors.

Thus, the chemical durability of glass surfaces depends upon a number of factors. For a glass of given composition, the durability of the surface depends greatly upon the type of origin (free-blown, drawn, blown in molds, pressed, etc.) and on the treatment afterwards (action of heat, chemically acting cooling gases, grinding, polishing, etc.). Comparison of the powder-method value and the surface-extraction value shows much fluctuation, but the general durability of glass may be estimated by the powder method.

1. Condensed from *Glastechnischen Berichte,* November 1934, by V. E. Wessels and S. R. Scholes.

NEW HEAT RESISTANT GLASS DEVELOPED BY CORNING

A new type of Pyrex glassware, capable of resisting all extremes of thermal shock encountered in home culinary use, has been announced by the Corning Glass Works. The new Pyrex makes possible the manufacture of pots, kettles and even frying pans. Housewives may now cook their stews and puddings in a glass saucepan, where the utensil comes directly in contact with the flame for prolonged periods, and they may then place the same dish in the icebox, to preserve the unconsumed contents for a later meal. It is called Top-of-Stove ware.

This new Pyrex is not new in the strictest sense, being in reality a development discovered in the course of researches conducted in connection with the 200-inch reflector for the world's largest telescope.

Some 1500 ultra low expansion glasses were tested to produce a glass with an expansion lower than that of Pyrex chemical glass, which has a coefficient of expansion of 32 x 10^{-7}. The minimum coefficient of expansion for telescope glasses was as low as 20. The glass adopted for Top-of-Stove ware has a coefficient of 38½. The reason for this extension over low values was that glasses, on continued exposure to high temperature of flame, set up internal stresses.

It was therefore necessary that the glass have heat resistance beyond that previously obtainable in any commercial glassware, and it must retain this heat resistance even when heated to the annealing point of ordinary lime glass. Its strain point must be so high that under normal conditions of top of stove use the new dish would remain practically unchanged over an indefinitely period of time.

Corning has succeeded in producing a glass sufficiently fluid at high temperature to melt and fabricate, yet of a low coefficient of expansion and high strain point so that, when it is specially treated, it has a heat resistance satisfactory for use on the top of a stove. The treatment in these processes, for which patents have been applied, makes the glass mechanically strong as well as thermally durable. At the same time, it has been found possible to reduce the wall thickness so that it is about two-thirds that of Pyrex Oven Ware. The new ware

Top-of-Stove ware can be used over the flame, in the icebox or on the table.

has further been distinguished from its companion Pyrex by the imprint of a flame in the bottom of each piece and by a distinctive color tint which has been called steel blue or stratosphere blue.

FLAT GLASS PLANT ACTIVITIES

Plans are being worked out to have a new corporation, largely made up of local capital, take over the property formerly known and operated as the National Flat Glass Co., in Independence, Kans. This plant will be operated to its full capacity of six Fourcault flat glass machines.

The Sunflower Glass Co., Sapulpa, Okla., is being refinanced so that their cylinder machine equipment may be replaced by three wide Fourcault machines. However, the completion of these plans is largely dependent upon improvement in window glass business.

From Fort Smith, Ark., comes word that the Harding Glass Co., which has been operating one tank with six Fourcault machines, contemplates starting up their other tank which is equipped with three Fourcault machines.

MODELING GLASS EYES

Newspapers last month made much of the woes of a certain Mid-West manufacturer of glass eyes. Desiring to improve the quality of his product, he commissioned a color photographer to provide him with color photographs of the most beautiful feminine orbs procurable. These, said the report, he intends to insert between two concave glass surfaces, to give the effect of natural eyes. All would have been well, had not the photographer, Henry Waxman, complained that beauty must start with the feet and work up.

CHEMICAL CLEANING OF MOLDS

PRESENT day mechanical methods of forming glass containers and other blown-in-the-mold glass objects involve high temperatures and considerable lubrication of the iron parts comprising the mold assembly. The result is that scaling of the metal and deposition of oil grease, and carbon on the mold parts is considerable. Efficient production and brilliant glass surfaces depend therefore upon the cleanliness of the mold assembly.

The cleaning of glass molds by chemical means involves two distinct procedures: the removal of the grease, oil and carbon; and the removal of the iron oxide scale. In the case of short run jobs and mold parts which are not subject to temperatures high enough to cause scaling, removal of the oil, grease and carbon is sometimes sufficient. If heavy scaling is encountered both removal of scale and oil is necessary.

It is common knowledge that benzol, kerosene, gasoline, alcohol and other organic solvents will easily remove oil, grease and carbon from the molds. The high cost of such solvents, the difficulty of recovering them for reuse and their fire-hazard, however, prevents their use for this purpose except in cases where only a few parts are to be cleaned or in cases where oil covered parts are removed from the storage rack and are cleaned free of oil before being placed on the machine.

The commonly used chemical methods for removing oils and greases from molds involve the use of alkaline solutions consisting of water solutions of materials such as caustic soda, tri-sodium phosphate, soda ash, sodium silicate or borax.

The action of these alkaline cleaners depends upon the type of oil or grease to be removed. In the case of saponifiable material, the oil or grease is in contact with the alkaline solution and the first action is physical, involving the dissemination of the oil in small drops throughout the liquid. In physical terms this action is called emulsification.

The next action is chemical and results in the combination of the fatty acid in the oil with the alkali to form a soap. The soap so formed being soluble in water dissolves and leaves the surface of the metal clean. The soap also aids in the formation of emulsions of the non-saponifiable oils and also in removing particles of grit by taking them into suspension.

In the case of non-saponifiable oils and greases, the first action of the alkaline cleaner is the same as in the case of the saponifiable oils. That is, an emulsification of the oil takes place. The globules of oil then slowly rise to the surface of the bath and through coalescence form a layer of oil on the surface. The emulsion of water with non-saponifiable oils is not readily formed and is not stable and the globules of oil do not readily separate from the surface of the iron. Boiling the solution helps to move the oil globules from the iron surface through agitation while the presence of saponifiable oils (which form soap in the alkaline solution) helps emulsification through its soap formation.

In practice, the dirty molds are placed in a rack and lowered into either a wooden or iron tub containing the alkaline solution and then boiled for half an hour. After boiling, the rack is removed and immersed in clean running cold water for about ten minutes to remove the alkaline solution. When cool the molds are rubbed off with a rag and the loose carbon deposit removed. If care is taken of the mold equipment and the oil and carbon not allowed to become baked on, this treatment will keep non-scaled parts in good shape.

The strength of the alkaline solution used for the oil removing treatment varies from 2.5 to 5 per cent. As a typical example, one glass plant is using an alkaline solution composed of 15 pounds of "Oakite Railroad Cleaner" to 60 gallons of water.

In addition to the boiling alkali method, oil and grease is often removed by the electrolytic method. This method decreases the time required and is more effective. The concentration of the alkaline solution used is about the same as in the above method, the only requirement being that the alkaline solution should be of high conductivity. In this method, the mold iron is made the cathode and an iron rod or iron cleaning tank made the anode. The main cleaning action results from the production of finely divided gases which lift off the oil or grease film and assist in its emulsification and/or saponification. The evolution of gas also serves to agitate the solution and bring fresh solution to the surfaces of the cathode.

The cleaning of scaled mold parts is accomplished by using an acid bath after the removal of the oil and grease. This acid treatment is termed "pickling." Dilute, hot solutions of sulphuric acid are used in this process. The action of the process is as follows: there are two separate reactions involved in pickling—action of the acid on the metal and the action of the acid on the scale. The reaction of the sulphuric acid and the scale may be represented by the following equations:

(1). $FeO+H_2SO_4=FeSO_4+H_2O$.

(2). $Fe_2O_3+3H_2SO_4=Fe_2(SO_4)_3+3H_2O$.

(3). $Fe_3O_4+4H_2SO_4=Fe_2(SO_4)_3+FeSO_4+4H_2O$.

Since the scale may contain all three oxide forms, all of the equations apply. As will be shown in equation (4), the acid when reacting with the metal evolves hydrogen which will reduce the $Fe_2(SO_4)_3$ formed in equations (2) and (3) to $FeSO_4$. The reaction of the metal and the acid is shown in the following equation:

(4). $Fe+H_2SO_4=FeSO_4+H_2$

The evolution of hydrogen is responsible for the mist which escapes from above the ordinary pickling bath and makes it a disagreeable process.

Pickling with ordinary sulphuric acid has the following disadvantages: the marring of the bright smooth metal surface; the embrittlement of the metal, due to the action of the hydrogen formed in equation (4); the loss of large quantities of metal and the excessive consumption of acid due to the fact that the scale only is not taken off, but that the unscaled metal also is attacked; the health hazard of the acid mist mentioned above; and the damage that the acid mist does to surrounding buildings and equipment. For these reasons an ordinary sulphuric acid bath is not used; but the use of a bath in which an

inhibitor is present is the general practice at present.

An inhibitor is a substance which, when added to the acid solution decreases the rate of attack of the acid upon the metal, decreases hydrogen evolution, but does not retard the action of the acid on the scale. Substances such as bran, molasses, sumac leaves, glue, etc., in addition to patented substances, have been added to the acid as inhibitors. Several new inhibitors have been developed through research and are now on the market. Simple tests will disclose the merit of each. Acids containing an inhibitor are also on the market.

The pickling process is accomplished as follows: the mold parts after being cleaned in the alkaline solution and washed in water are placed in a 3.5 to 8 per cent solution of sulphuric acid containing a suitable inhibitor, using the same rack as was used in the oil removal process. A Monel Metal rack is especially suitable as it is acid resisting and will hasten the pickling process through electrolytic action. The scaled parts are kept in the solution for 5 to 10 minutes, the acid solution being kept at a temperature of 130 to 150° F. After removal of the rack from the pickling bath, it is immersed in cold running water for about 5 minutes and then immersed in a solution containing about 1 per cent of alkali for about 10 minutes. This acid neutralizing solution is used at a temperature of about 150° F. and its purpose in addition to neutralizing the surface acid is to penetrate into the pores of the iron and neutralize the acid in these pores. After neutralization of the acid the molds are wiped clean with a rag and then dried.

The advantages of chemical cleaning methods over abrasion cleaning methods, when considering glass molds, are as follows: several sets of molds and mold equipment may be cleaned at one time; chemical cleaning does not destroy the mold edges, etc; oily and greasy equipment is usually not dirty enough to clean by abrasion methods but still is too dirty to be used. With the chemical method the oil is quickly and completely removed.

While the chemical method is not completely successful when the oil and carbon is baked on the iron and abrasion methods are needed to remove it, it is poor practice to allow equipment to get in such a condition.

"Chip the empty bottles" by tapping the pouring lip, is the advice urged upon consumers by J. M. Doran, administrator of the Distilled Spirits Institute, as the way to break the power of the bootlegger.

The first steel upright goes into position in the new building of the Maywood Glass Co., Los Angeles.

PACIFIC COAST NEWS

Maywood Glass Co. has begun the erection of a new steel building on its property in Los Angeles. Concrete foundations were built some weeks ago, but the first steel member of the supporting structure was raised to its position on Jan. 14. When finished, the new building will be 65 x 120 feet and its cost is estimated at $50,000. This addition to the plant will provide room for a new tank with a capacity of 35 tons, and will enable the company to run continuously on both colored and flint glasses. Maywood is also erecting an attractive brick wall, the front portions of which are already completed, as the first step in a program to beautify its property.

● On Dec. 24, the McLaughlin Glass Company, Los Angeles, filed a petition in bankruptcy. H. L. Laughran, 636 Subway Terminal Building, was appointed receiver. The extent of the insolvency has not as yet been fully determined.

● A new factory building, with equipment equal to any on the Pacific Coast, will shortly be erected in Oakland by the Owens-Illinois Pacific Coast Co. Plans have been completed and it is reported that work on the foundations will commence on March 1.

● Latchford Glass Co., Huntington Fark, Los Angeles, recently completed a new two-story building of concrete and steel for their packing department, to replace an old wooden structure. A feature of its construction is the fabricated steel flooring which, although extremely light, is capable of supporting very heavy loads.

● Hazel-Atlas Glass Co. of California, Ltd. is completing a new office building on its property in Oakland. The company maintains a city sales office in San Francisco, but its general factory and sales offices are in Oakland, and will be housed in the fine new building.

● Dr. Willi M. Cohn has been appointed head of the Ceramic Department of the California School of Fine Arts, San Francisco, for the year 1936. He will be assisted by Mrs. Gertrude P. Wall.

AUTOS TAKE MOST OF PLATE GLASS

According to statistics recently released by the Automobile Manufacturers Association, 77 per cent of the country's plate glass production is utilized by the automotive industries. It is interesting to note that this industry is America's largest purchaser of many raw materials. 23 per cent of iron and steel, 75 per cent of rubber, 39 per cent of lead, 33 per cent of nickel, 22 per cent of copper, 16 per cent of aluminum, 15 per cent of zinc and 20 per cent of tin was consumed by this one industry.

The remaining 23 per cent of plate glass production is distributed among the building industry, mirror manufacturers, the furniture industry and other smaller markets, but in what proportion it is at present impossible to determine.

Consolidated Lamp & Glass Co., Coraopolis, Pa., founded in 1893, will re-open its plant during the first week in February. This firm manufactures Cora-Lite for commercial lighting, as well as illuminating glassware and novelties.

THE NATURE OF THE SELENIUM-PINK COLOR

By W. HOFLER and A. DIETZEL[1]

THERE can now be no doubt about the chemical nature of the color since the work of Fenaroli, Witt and Frankl, and especially of Hofler. It is due to elementary selenium. But the question is in what state of division is the selenium which produces the color. Fenaroli has investigated this thoroughly and calculates that the particles have an average distance apart of 0.37 to 0.64μ and a diameter under 40 mμ. He has, therefore, concluded that the pink is a colloidal color. It is comparable to a copper or gold ruby. This is the prevailing opinion today.

In the course of our research on selenium glass, we made various observations which could not be brought into accord with this view.

We will first consider ruby glasses. The color is recognized to be due to colloidal gold or copper which has separated from the glass as small metallic crystals at about 600° to 800°. In this temperature range, both metals are solids. Selenium, on the other hand, is gaseous above 690° and liquid between 690° and 219°, and only crystalline below 219°, (provided it finds time to crystallize). A precipitation of selenium crystals is, therefore, out of the question. Droplets of selenium could, perhaps, separate out below 690° at about the transformation point. It would then be expected that the size of the particles would depend on the time the glass remained in this temperature range and the growth of the drops would correspondingly alter the color. According to Hofler's research, which we have frequently confirmed, rate of cooling has no influence on the selenium color.

If one wishes to assume the presence of selenium particles, nevertheless, then quick cooling would freeze the droplets in the glass, while slow cooling would permit crystallization. According to experience with sulphur in non-silicate dispersion mediums, it is to be expected that the different states would determine different colors. We now have a pink glass which has been held 14 days between 90° and 100°, the most favorable temperature for the conversion of glassy seleniums to crystalline. But the color has not changed.

The single experimental grounds for Fenaroli's view that selenium is in colloidal dispersion was the observation that ultra-microscopic particles were present in selenium glass. In order to prove this, we examined a series of selenium glasses with a narrow light of high intensity. The selenium pink glasses showed the purple cone described by Fenaroli; it was not a Tyndall effect but a fluorescence. The light of the cone is not polarized and the cone appears red in blue light. It disappears in transmitted red light. Furthermore, we examined splinters of selenium glass under a magnification of 1500 and found neither particles nor their refraction effect. In contrast, we could easily determine particles in copper, gold, silver and selenium-cadmium ruby glasses. And so we believe that the particles observed by Fenaroli were not selenium droplets but were colloidal devitrification crystals.

Fenaroli has introduced a certain support to his theory by claiming a color agreement between a selenium glass and an aqueous colloidal selenium solution. Such solutions show indeed a certain similarity to the dark brownish red of soft soda glass such as Fenaroli melted. However, these had already shown a transformation to the brown polyselenide glasses. The pure selenium pink which Hofler made in glasses with less than 24 per cent potash or 12 per cent soda in a pure neutral or oxidizing atmosphere and which we are considering here, have a clear pink color with a blue cast and do not resemble in any way the lake red or cinnabar red and brown of colloidal aqueous solutions.

We might mention an additional explanation to the problem which has been observed by E. Frankl. The selenium pink color is first noticed on cooling the melt to a comparatively low temperature. At 600° to 500° a yellow color is first observed. At 400° to 300° it becomes lake and only below this temperature does a pink color develop. On cooling from 200° to room temperature, it becomes stronger and purer. Proceeding in the reverse manner, the color changes from pink to yellow upon heating the glass, and the reaction is reversible. It is especially noteworthy that this color change does not stop at room temperature.

If a soda glass, which is distinctly lighter than a potash glass with the same percentage composition, is placed in liquid air at about—180° it becomes practically the same color as the potash glass at room temperature. Upon being taken out of the liquid air, it gets back its original color again. Correspondingly, if the potash glass is heated to about +200° it has the same color as the soda glass at room temperature. As far as we can determine, this color change takes place instantaneously.

To sum up our present knowledge of the reaction, the following assumptions may be made:

(1) The selenium is dissolved somehow in the melted glass in the form of a gas and separates on cooling in an extraordinarily high state of dispersion. This explains why the color change continues even to room temperature.

(2) Selenium is set free during the cooling by some such reaction as:

$$2\ Na_2Se + Na_2SeO_3 = 3\ Se + 3\ Na_2O$$

It might be mentioned here that the series of color changes in falling temperature correspond with those found by Hofler, with increasing acidity at constant temperature. It can be assumed that the displacement of such an equilibrium in solid glass could take place.

From the above, it can be said without doubt that, since the selenium pink color is first visible below 400° and becomes stronger even to 0°, the formation of selenium droplets cannot be assumed.

A joint meeting of the Optical Society of America and the American Physical Society will be held at Columbia University, Feb. 21 and 22. Additional sessions may be held Feb. 20, if warranted by the number of contributed papers. In addition to the papers contributed by members of the Optical Society, a joint session will be held with the Physical Society on the diffraction grating. The meeting will also be open to non-members.

[1] Glastech. Ber. **12**, 297-299 (1934).

SANDWICH GLASS

By ALEXANDER SILVERMAN

Head of the Department of Chemistry, University of Pittsburgh

Through the cooperation of Professor Silverman, The GLASS INDUSTRY *is able to present a very remarkable series of articles on Sandwich Glass. Having access to important original sources, for the first time accessible, Professor Silverman has been able to uncover the original batch formulae used in the manufacture of this glassware. Thus, although much has been written about Sandwich Glass, this is believed to be the first comprehensive presentation and interpretation of the batches employed. This first article* deals with crystal glass, and in addition, includes some novel historical material. It will be evident from the study of this series of articles that the various men in charge of glass making at the old factory on Cape Cod had a broad knowledge of the glass technology of their time and that they possessed real versatility in the art.—The Editor.*

NUMEROUS popular articles have appeared about Sandwich Glass, and its products have been described in books[1] and magazines. It will be recalled that Deming Jarves of Boston broke ground in Sandwich, Massachusetts, on Cape Cod in April, 1825, "for the establishment of a Flint Glass Manufactory[2]" and that on the Fourth of July of that year, the first piece of glass was blown in the form of a rod, which is in the possession of the Sandwich Historical Society. Its crude nature and color indicate that local sand was employed. With its impurities the sand alone could hardly have been the inducement to establish the factory at Sandwich.

In 1826 the Boston and Sandwich Glass Company was incorporated. The annual production by its sixty or seventy men was valued at $75,000. In "1854 the capitalization was $400,000" and there were over five hundred employees, with an annual production valued over $600,000. The business reached its peak by the beginning of the Civil War, when "two million dollars had been spent for molds and machinery" and three-fourths of the glass was used for pressed ware, previously made in Holland and England. This has since been perfected in America to its greatest height, as a study of the evolution of our glass industry indicates.

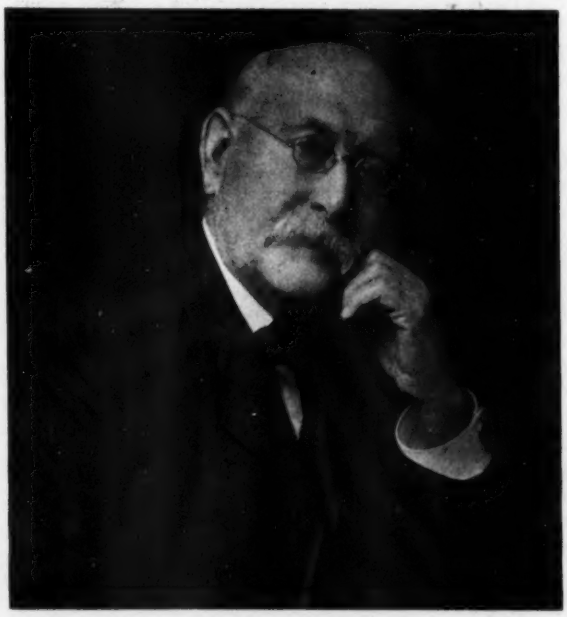
The factory at Sandwich "consisted of an upper house where glass was blown and a lower house for pressed ware." The two together were known as the "glass house." In addition to the glass house there was the "round house" where the products were stored and the "counting house" occupied by the business management.

Although the theory that this factory was located at Sandwich because of its natural sand deposits has been questioned by Miss Setzer and others, there is little doubt that the unrestricted use of pine wood from the Cape forests as a fuel in the furnaces was an inducement. In the latter eighties coal attracted glass manufacturers to the Pittsburgh district in Pennsylvania, and although this natural fuel would in time have furnished serious competition, it was the organization of labor in the Pittsburgh plants that caused the Boston and Sandwich Company to close the factory. "A delegation of workers from Pittsburgh came to Sandwich and sowed the seed of discontent."

The Sandwich employees formulated plans for organization and the demands of their union were such that the directors could not afford to meet them. The management "issued an ultimatum that, if there was a strike and the fires be allowed to go out, the factory would never reopen. There was a peculiar clause in the charter which provided that it would automatically expire should the fires be extinguished," for it must be remembered that the Sandwich plant operated day and night, usually in four alternate shifts. Employees worked during two alternate shifts per day. "When the workers, believing the company to be bluffing, called the strike, the plant was definitely closed, January 1, 1888."

It is the consequence of this act that has probably made Sandwich Glass so precious, and a variety of plates, goblets, and other table ware, lamps, vases and works of art, pressed and blown, in crystal, opal, and every color made in that day is eagerly sought by museums and private collectors. As yet nothing has been published regarding the variety of batches, or mixtures of raw materials, used for making Sandwich glass.

It was the writer's good fortune in the Fall of 1924 to

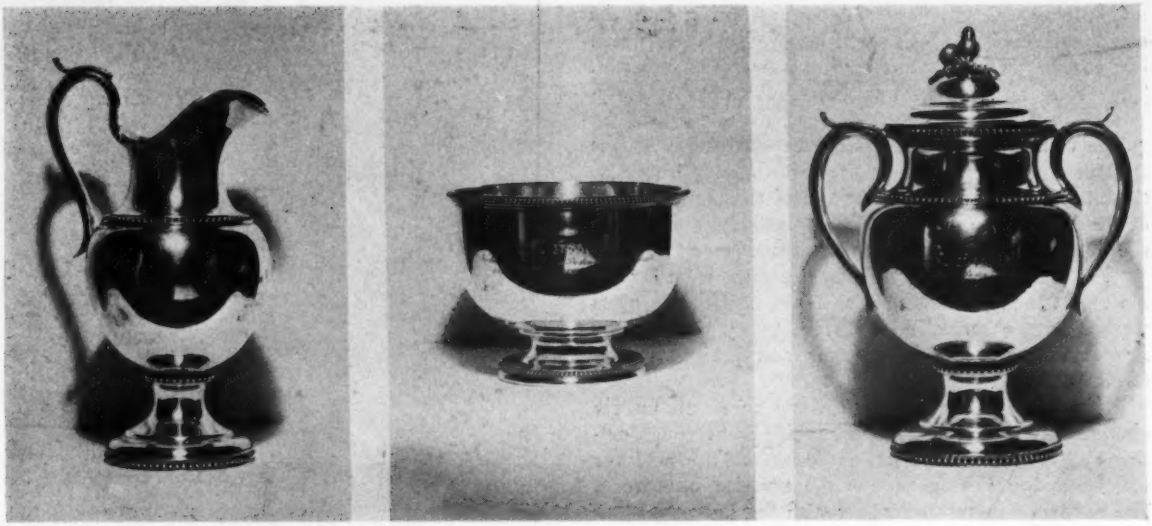


William E. Kern

[1] Deming Jarves, "Reminiscences of Glass Making," Eastburn's Press, Boston, Mass., 1854; Frederick T. Irwin, "The History of Sandwich Glass," The Granite State Press, Manchester, N. H., 1926; Rhea Mansfield Knittle, "Early American Glass," Century Company, New York, 1927; Ruth Webb Lee, "Early American Pressed Glass," Pittsford, N. Y., 1931; Frank W. Chipman, "The Romance of Sandwich Glass," Sandwich Publishing Co., Inc., Sandwich, Mass., 1932.

[2] Dorothy Setzer, "The Sandwich Historical Society and Its Glass."

* Contribution No. 306 from the Department of Chemistry, University of Pittsburgh.



Silver service presented to George Fessenden by the workmen.

meet William E. Kern of New Bedford, Mass., who was first employed in Sandwich in 1843 and who possessed a varied collection of its products. Born February 8, 1832, he was ninety-two years old when, a tall gentleman of military bearing, he opened the front door to his visitor, your writer. Mr. Kern climbed up a ladder in the closet in which some of his treasures were stored and personally displayed one piece after another, pressed ware, blown glass, crystal and cased cuttings and engravings. No one but he himself was permitted to show the pieces. Mentally he was as alert as any young man could be, and physically he might have been envied by many a youth. Mrs. Silverman and I admired his treasures, and then I ventured upon a suggestion which, when I think back, was bold to say the least: did he possess the batches which were employed in the Sandwich factory and if so would he entrust them to my care for copying? Without the slightest hesitation Mr. Kern ascended to the second floor, brought down his records, and permitted me to take them to Pittsburgh without any restriction except that the batch books should be returned to him. Mr. Kern died August 30, 1928. The fortunate meeting with Mr. Kern is responsible for some of the information which will be included in these articles.

The writer is also happy to possess the friendship of a daughter of the late George L. Fessenden. He was works manager of the Sandwich plant for many years and was greatly beloved by the workmen. The extent of this affection is indicated by two of the illustrations which accompany this article, one showing the silver service which was presented to Mr. Fessenden in 1860, the other showing the document which accompanied the gift, listing the names of the workmen who presented it.

His brother, the late Sewell H. Fessenden, was business manager of the company.

Some of the historical material which has already been given was received through the courtesy of the daughter of George L. Fessenden, and batches and other factory records were graciously made available. The photographs of the two gentlemen mentioned are copies of her originals.

It is rather a coincidence that in an address entitled "Reminiscences of the Boston and Sandwich Company" delivered in Boston about 1908, Mr. Kern, of whom I have already spoken, states that as a boy he, like others, was permitted to spend his spare time in the Sandwich factory trying to acquire skill and insure advancement. On one such occasion he made a glass lamp standard of gold ruby plaited with opal glass. When it came through the lehr, Sewell Fessenden saw it and on learning that young Kern had produced the article sent it to the cutting room, then to Boston to have brass parts fitted, and presented the completed lamp to the boy. Again, when Mr. Kern left the factory in 1867 Mr. Fessenden asked if he would like to have some glass as a farewell souvenir. Mr. Kern replied that he should like to select a few pieces personally. He was overwhelmed when Mr. Fessenden presented him with a collection of over fifty articles of cut glass, the best which the factory afforded. This incident indicates the attitude of the management towards faithful employees.

An interesting point which comes to mind as the result of conversations with the daughter, accounts for the abundance of Sandwich glass in Pennsylvania. Many of the citizens of Sandwich were Quakers. On the occasion of their meetings, religious brethren from Philadelphia visited them frequently. On their departure from Sandwich they were generously supplied with the glass of local manufacture. While the writer wishes to spare George L. Fessenden's children and others who have precious historical information regarding Cape Cod and the famous old Sandwich factory, it is hoped that this interesting information will not be lost to posterity.

Crystal Glass

When the Sandwich factory was started in 1825 there was one glass house. In 1849 a second was built. As previously stated these were known as the "upper" and "lower" houses. "Each contained two ten-pot furnaces[3]." In the beginning pine wood was burned in the furnaces and glory holes until its scarcity compelled the use of coal. About 1850 resin was used in the glory holes, continuing until the Civil War when it became "to scarce

[3] William E. Kern, "Reminiscences of the Boston and Sandwich Company" 1908 (?).

and valuable for such use." According to Mr. Kern the company possessed about seven hundred barrels "which had cost in the neighborhood of sixty-two cents a barrel. The whole lot were sold to the Government at forty-four dollars a barrel."

The company next introduced the use of gas in the furnaces, evidently coal gas, for this was furnished to the citizens of Sandwich as well; and then coke instead of seasoned oak in the lehrs. This probably was the first use of coke in American glass manufacture.

"The molds employed for pressing glass were for the most part made of brass. For large articles the press worked with a screw instead of a lever. In these the figures were cut on the plunger and pressed upside down."

In the treating of crystal glass, designs were not merely obtained through patterns in the molds and through cutting and engraving, but it was desired to use acid for etching and polishing as was the practice in Europe. The company, being unfamiliar with the processes, sent one of its men, Franklin Lapham, to England to learn the methods. Although hydrofluoric acid was used for etching, it was probably not employed for polishing, and the putty method was used instead.

Kern Batches

The first lot of batches which follows is taken from the original memorandum book of William E. Kern. The batches are given in the exact wording of the original records, with such comments as the writer can make concerning ingredients and their uses. The numbers simply refer to the writer's records. It will be observed that batch titles indicate sources from various European countries. In an address which Mr. Kern made, there is a reference to the Boston and Sandwich Company's policy of purchasing the best information obtainable from Europe and at times, spending considerable sums to have experienced individuals come from abroad to prepare colored glasses which were difficult to produce.

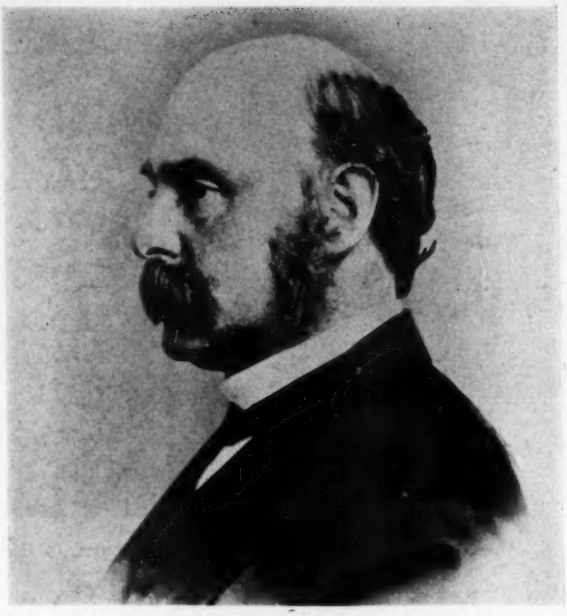
No. 1. German Flint:

Sand	1200 lb.
Lead	200 lb.
Pearl ash	300 lb.
Nitrate soda	75 lb.
Bicarbonate of soda	75 lb.
Lime	75 lb.
Arsenic	7 lb.
Bone	4 lb.
Manganese	21 oz.
Nickel	60 gr.

Where the term "lead" is used it probably refers to red lead. Observe that bicarbonate of soda is employed extensively in crystal batches. It was probably much purer than soda ash made by the Le Blanc process. "Bone" probably means bone ash; manganese, manganese dioxide or pyrolusite, which is less pure; and nickle, the green oxide. Arsenic means arsenic trioxide as in modern practice.

No. 2. German Flint tried in Cape Cod:

Sand	1000 lb.
Lead	200 lb.
Pearl ash	400 lb.
Nitrate soda	50 lb.
Lime	75 lb.
Bicarbonate of soda	30 lb.
Arsenic	7 lb.
Bone	7 lb.
Manganese	20 oz.
Nickel	60 gr.



Sewell H. Fessenden

Obviously some difficulty was encountered in melting the original German glass at Sandwich, for the pearl ash content is increased appreciably. The bone content was also increased. It is interesting to note that the early use of small quantities of bone ash has come down through generations and that the practice is still followed in some of the modern plants where flint glass is manufactured.

No. 3. Kern's Common Flint:

Sand	1200 lb.
Lead	300 lb.
Pearl ash	350 lb.
Bicarbonate of soda	125 lb.
Nitrate soda	60 lb.
Lime	20 lb.
Arsenic	4 lb.
Bone	4 lb.
Manganese	30 oz.

This batch was probably called "common" flint because bicarbonate of soda was used in increasing the flux. The increase in use of manganese seems to indicate that American raw materials contained more iron.

No. 4. Lloyd's Lime Batch:

Sand	1200 lb.
Bicarbonate of soda	500 lb.
Lime	100 lb.
Potash	200 lb.
Nitrate soda	130 lb.
Arsenic	5 lb.
Manganese	29 oz.

Potash probably means pearl ash or the hydrated crystals of potassium carbonate. Some early manufacturers used the hydroxide or caustic potash, but it is doubtful whether this was in use at Sandwich.

No. 8. Lloyd's Lime:

Sand	1200 lb.
Bicarbonate soda	700 lb.
Lime	100 lb.
Nitrate soda	130 lb.
Arsenic	5 lb.
Manganese	29 oz.

By comparing batch No. 8 with No. 4 one sees that

bicarbonate of soda was increased to replace the potash entirely, probably in the interest of economy.

No. 9. Kern's Crystal:

Sand	1300 lb.
Lead	400 lb.
Pearl ash	600 lb.
Nitrate soda	50 lb.
Bone	30 lb.
Phosphate soda	13 lb.
Arsenic	4 lb.
Borax	4 lb.
Manganese	12 oz.

Comparing this batch with No. 3 one observes the omission of bicarbonate of soda and the complete substitution of pearl ash, which differentiates Kern's Crystal from his Common Flint batch. There is also the first reference to borax.

No. 10. Christol Lime, Kern:

Sand	800 lb.
Lead	180 lb.
Pearl ash	400 lb.
Lime	120 lb.
Bicarbonate soda	25 lb.
Nitrate soda	25 lb.
Bone	4 lb.
Arsenic	4 lb.
Manganese	9 oz.
Nickel	40 gr.

Here an appreciable amount of lime replaces the red lead.

No. 12. Very Bright Kern Flint:

Sand	1300 lb.
Lead	300 lb.
Pearl ash	300 lb.
Bicarbonate soda	250 lb.
Lime	100 lb.
Nitrate soda	50 lb.
Arsenic	8 lb.
Bone	5 lb.
Manganese	18 oz.

The title of this batch is interesting. Observe that nickel oxide was employed as a decolorizer in preceding batches and that here only manganese dioxide is used. Nickel glasses appear black when viewed edgewise and do not possess the brilliance of those decolorized with manganese dioxide.

George L. Fessenden

No. 14. Best Batch for Cutting:

Sand	1200 lb.
Lead	800 lb.
Pearl ash	400 lb.
Nitre	75 lb.
Bone	4 lb.
Borax	5 lb.
Arsenic	5 lb.
Manganese	16 to 24 oz.
If English Lead	2 to 6 oz.

This is the first batch which refers to cutting crystal. Note that English red lead requires less decolorizer than the American product.

No. 16. Lime Batch, Harrup:

Sand	1500 lb.
Litharge	100 lb.
Soda ash	540 lb.
Lime	115 lb.
Nitrate soda	130 lb.
Feldspar	14 lb.
Arsenic	20 lb.
Manganese	4 lb.

Best Batch, Harrup:

Sand	1200 lb.
Lead	800 lb.
Pearl ash	400 lb.
Nitre	90 lb.
Manganese	12 oz.

It is amusing that both of these should be called lime batches, for to obtain his best results Harrup omitted lime entirely in the second batch. This is the first time that we encounter soda ash, feldspar, and litharge in a crystal batch.

No. 17. Hopkins Batch:

Sand	374 lb.
Bicarbonate soda	67 lb.
Nitrate soda	71 lb.
Carbonate potash	81 lb.
Carbonate lime	67 lb.
Lime	60 lb.
Sand	1466 lb.
Carbonate soda	259½ lb.
Nitrate soda	144 lb.
Carbonate potash	306½ lb.
Carbonate lime	286 lb.

The second batch is not a multiple of the first. Note that this is the first reference to carbonate of lime.

No. 22. Northwoods Lime:

Sand	1500 lb.
Soda ash	440 lb.
Nitrate soda	100 lb.
Carbonate Lime	150 lb.
Manganese	2 lb.
Arsenic	4 lb.

This is the extent of records covering crystal glass in Mr. Kern's batch book.

Fessenden Batches

The bound volume which contains these records is exemplary for the neatness and care displayed. One finds frequent comment regarding the testing of mate-

rials and the preparation of special reagents. They clearly indicate the responsibility which Mr. Fessenden felt as general superintendent. Some examples follow:

Here is his simple method for testing manganese. "Boil a small quantity of manganese in sulphuric acid, then add water to dilute the acid and filter the liquor, then add a little Prussiate of Potasse in solution and if your manganese is quite pure your liquor will become as white as milk; if it contains iron it will become blue, the darker the blue the more iron your manganese contains. The lighter your liquor is in color after the addition of the solution of Prussiate (hydrocyanide)? of Potasse the better. This is of course not an absolutely accurate or minute test, but it is quite near enough for all ordinary glassmaking purposes. You dissolve the Prussiate of Potasse in water."

Evidently the Sandwich plant manufactured its own litharge or red lead. The Macbeth-Evans Glass Company still followed this practice in 1902.

Mr. Fessenden next gives a method by a Dr. Hughes for testing lead. "Cut from half the pigs small bits of lead and melt them in a ladle. Pour all into cold water to divide into fragments, 2 oz. of the fragments, 5 oz. of distilled water, heated in a flask and pure nitric acid added to form a solution; about two ounces will be required; all should be dissolved when the liquor is boiling hot. If a white powder remains it is either oxide of tin from tin metal or sulphate of lead from sulphur. Pour off the clear liquid into porcelain and evaporate rapidly. Nitrate of lead will form and fall down as white granular salt and finally about two tablespoonfuls of liquor will remain. Cool and pour the whole into a clear funnel placed in a glass jar having previously partially stopped the funnel neck with some pieces of glass, so as to retain the salt from which liquor will drain off and have clear liquor. Nearly all of the lead will thus be removed. And the impurity will be found in the liquor. If more than two tablespoonfuls evaporate again, but about ½ a fluid oz. will remain. If this is colored you may expect impurity. Divide in two glasses. Add to one glass pure Aqua Ammonia. After diluting the ¼ oz. of fluid with 2 oz. water, if a white bulky mass forms and the excess of ammonia above it is colorless, the lead is pure. Pour all on clean filter and if the clear fluid is colorless you need not proceed further. Should the fluid be colored blue you have either copper or nickel. If purplish, cobalt. If the precipitate of ammonia is not white, iron is present in it. Evaporate in porcelain and dry off the whole. Add to the cold, dry salt distilled water. The nitrate of lead will dissolve. White ashy flakes of iron oxide will be left if iron is present. Copper and cobalt with nickel are your great enemies and purification in the furnace is the best course in every case."

He also notes a process by a Dr. Hayes, (February 27, 1866), for correcting the bad quality of pig lead. "Even with selected lead bought there are chemical impurities occurring and these may be corrected as follows: Melt as usual for making Litharge and draw off carefully *all* the first oxide apart from any other. Draw the second coating of oxide after thorough stirring in the same way and dispose of these oxides as painters Litharge. The remaining Lead will give pure oxide. Or after first skimming the melted lead add 2% pure nitrate of soda. Stir well and long, then melt the oxide formed, draw off, rejecting this for glass. The principle is that the impurities arise with the first and second portions of oxide, while pure lead remains and can then be corrected to oxide as usual."

Then various notes follow. Bicarbonate of Soda 245 3/10 lbs. equal 100 lbs. of 92% Soda Ash. 100 lbs. dry pure Salt Petre equal 84 3/10 lbs. nitrate of soda. 100 lbs. dry pure Lime equal 200 lbs. dry carefully slaked lime. Fluorspar is a compound of fluorine and calcium and it bears the same relation to lime as common salt to soda. It melts easily to clear glass becoming brittle when cold and it will melt other bodies such as Alumina, behaving somewhat like Borax. Feldspar is generally composed of Silica, Alumina and Potash. It melts easily to a clear glass, becoming opaque as it cools. It will frit other bodies but give an opaque solid."

The batches follow exactly as recorded by Mr. Fessenden. The numbers are Mr. Fessenden's. Note that Mr. Fessenden frequently uses foreign terms for his raw materials. It is in these records that we encounter numerous foreign batches to which reference was made in the introduction to Mr. Kern's batches.

No. 19. Best English Flint:

Sand	1000 lb.
Litharge	600 lb.
Potasse	300 lb.
Nitrate of Potasse	100 lb.
Borax	25 lb.
Arsenic	3 lb.
Manganese	14 oz.

Potasse probably is a common French glass house term for pearl ash. Nitrate of potasse is also mentioned for the first time in contrast to nitre and nitrate of soda in the Kern batches.

No. 20. Best Dutch Flint:

Sand	1200 lb.
Litharge	640 lb.
Potasse	360 lb.
Nitrate of Potasse	40 lb.
Arsenic	3 lb.
Manganese	1 lb. 4 oz.

No. 21. Common 62 for General Work:

Sand	1200 lb.
Litharge	500 lb.
Potasse	100 lb.
Bicarbonate of soda	275 lb.
Nitrate of soda	100 lb.
Chalk or Lime	75 lb.
Arsenic	3 lb.
Manganese	1 lb. 14 oz.
Cobalt	18 gr.

"All flint glass which contains Lead should be filled with at least one half cullet; it is always better." The alternative of using chalk or lime is confusing, for the former is carbonate and the latter usually implies burnt lime. Cobalt, probably the black oxide, is mentioned for the first time. Evidently this was introduced directly instead of blue glass or powdered blue. Perhaps the latter practice had not yet come into being for insuring a more uniform effect.

No. 22. Another Very Good Flint:

Sand	1200 lb.
Litharge	500 lb.
Potasse	200 lb.
Bicarbonate of soda	175 lb.
Chalk or Lime	75 lb.
Nitrate of soda	100 lb.
Arsenic	3 lb.
Manganese	1 lb. 12 oz.
Cobalt	15 gr.

No. 23. Second Quality Dutch:

Sand	1200 lb.
Litharge	640 lb.
Potasse	180 lb.
Bicarbonate of soda	180 lb.
Nitrate of soda	40 lb.
Arsenic	3 lb.
Manganese	1 lb. 8 oz.
Cobalt	10 gr.

"I have often made this without any cobalt, but I think that a little is good to counteract the tint from the soda." Whether "second quality" refers to a somewhat inferior batch from Holland or to a modification at Sandwich is not indicated.

No. 24. For Common Work. G.L.F.:

Sand	1200 lb.
Litharge	550 lb.
Potash	175 lb.
Bicarbonate of soda	200 lb.
Nitrate of soda	100 lb.
Lime	75 lb.
Arsenic	3 lb.
Manganese	1 lb. 14 oz.
Cobalt	16 gr.

This is probably a modification developed by Mr. Fessenden himself.

No. 25. Flint for Casing:

Sand	300 lb.
Litharge or Minium	200 lb.
Potasse	80 lb.
Nitrate of Potasse	10 lb.
Arsenic	1 lb.
Manganese	8 oz.

"This flint is better than the ordinary flint if you have heavy pieces or many colors to case as it is more sure." This is the first reference to a glass for repeated gathering or casing. Litharge and minium, or red lead, were used interchangeably without weight correction.

No. 26. Flint without Lead; (Demicristal):

Sand	500 lb.
Soda ash, fifty two degrees	200 lb.
Chalk	180 lb.
Nitrate of soda	20 lb.
Arsenic	1 lb. 8 oz.
Manganese according to furnace, say	1 lb. 8 oz.
Cobalt	16 gr.

"This batch is very soft and fluxes very quickly. Of course where you use it for colored metal you omit the arsenic, manganese and cobalt." Our 58 per cent soda ash has reference to the sodium oxide content. The ash in No. 26 is lower in alkali as it was probably Le Blanc soda. In this batch we have the first reference to the omission of decolorizers if it is to be used for making colored glass.

No. 43. Best Flint:

Sand	620 lb.
Lead	220 lb.
Ash	300 lb.
Salt Petre	22 lb.
Borax	2 lb.
Arsenic	¼ lb.
Manganese	½ lb.
Phosphate soda	6 lb.
Phosphate Lime (Bones)	1½ lb.

As this batch is called Best Flint, ash probably means pearl ash for salt petre is employed, which is potassium nitrate. This batch also makes it clear that "bones" signify bone ash or calcium phosphate.

No. 48. French Flint:

Sand	1000 lb.
Lead	400 lb.
Ash	400 lb.
Salt Petre	50 lb.
Borax	10 lb.
"Mang. to Furnace"	

Here the first reference is made to a practice which is still followed in some glass plants. This is the first batch in which manganese is omitted, with instructions to add it to the batch while it is melting. We still have quite a number of plants where a certain amount of manganese dioxide is added to the batch and where the melt is "doped" from time to time by further additions during the melting. This practice is followed for both pot and tank glass.

No. 49. Lime Glass:

Sand	1000 lb.
Soda ash	450 lb.
Nitrate soda	50 lb.
Lime	200 lb.
Arsenic	1 lb.
Manganese	2 lb.

No. 50. Cheap Flint Glass:

Sand	200 lb.
Feldspar	150 lb.
Soda ash	80 lb.
Salt Petre	20 lb.
Lime	30 lb.
Manganese	½ lb.
Arsenic	¼ lb.

A very small amount of feldspar was indicated in Kern's Harrup lime batch No. 16. In the batch given above, we have the first large amount of feldspar used in a crystal glass (misnamed flint) in Sandwich.

No. 51. Another Com. Flint:

Sand	1000 lb.
Potash	150 lb.
Soda ash	150 lb.
Lead	100 lb.
Salt Petre	60 lb.
Lime	60 lb.
Manganese	1 lb.
Black Antimony	1 lb.
Arsenic	½ lb.

This is the first reference to black antimony, in fact to any antimony compound. Black or gray antimony is the native trisulfide, freed from siliceous material and arsenical compounds. It is also known as "needle" antimony.

George L. Fessenden's book is divided into two parts. The following records are contained in Part II.

No. 59. Best English:

Sand	1000 lb.
Refined Ashes	300 lb.
Red Lead	600 lb.
Nitrate of Potash	100 lb.
Borax	25 lb.
Arsenic	3 lb.
Manganese according to furnace about	12 oz.

This batch contains the first reference to refined ashes. It was the practice in Europe, especially in the Black Forest in Bohemia, to take the wood ashes from the furnace fires, leach them, and refine the solution by crystallization using the product as a flux in glass making. The writer does not know whether this practice

was followed in American plants. The composition of various ashes employed in glass making is given in an earlier article by the writer[4]. In interpreting the last item in the batch it is a question whether the furnace alone had to be considered or whether the quality of the ashes was also a factor. Comparing batches No. 59 and No. 19, one should expect No. 19 to be the better except for the use of red lead in No. 59 and the "doping" of the glass according to furnace conditions.

No. 60. Another English Flint:

Sand	1000 lb.
Red Lead	550 lb.
Refined Ashes	300 lb.
Nitrate of Potash	100 lb.
Arsenic	3 lb.
Manganese	12 oz.

No. 61. Good fair English Flint:

Sand	1000 lb.
Red Lead	550 lb.
Refined Ashes	150 lb.
Bicarbonate of soda	200 lb.
Nitrate of Potash	100 lb.
Chalk	100 lb.
Arsenic	3 lb.
Manganese	1 lb. 4 oz.
Cobalt	10 gr.

Batches No. 59, 60 and 61 show the relative qualities of English glasses, as No. 63, 64 and 65 indicate the relative value of the Dutch.

No. 62. Good press Metal English:

Sand	1200 lb.
Red Lead	500 lb.
Bicarbonate of soda	275 lb.
Refined Ashes	75 lb.
Nitrate of Soda refined	100 lb.
Chalk	100 lb.
Arsenic	3 lb.
Manganese	1 lb. 6 oz.
Cobalt	14 gr.

This is the first specific reference to a batch for pressing glass. Here we also have the first reference to "refined" nitrate of soda. It is interesting to mention in passing that the iodine compounds present as impurities in crude niter from Chile seem to have been a factor in refining glass. A recent patent[5] covers the introduction of iodine compounds into the batch, probably for the purpose of accomplishing results produced by impurities before the newer processes for nitrate production were developed, even though the batches covered in the patent usually contain a reducing agent. The use of iodine under these conditions insures freedom from bubbles or seeds in the new glasses.

No. 63. Dutch Flints (Best):

Sand	300 lb.
Red Lead	160 lb.
Refined Ashes	90 lb.
Nitrate of Potash	10 lb.
Arsenic	1 lb. 8 oz.
Manganese	6 oz.

Comparing this batch with No. 20 we might decide in favor of No. 63 because of the use of red lead and the consequent use of less decolorizer.

No. 64. Second Quality:

Sand	300 lb.
Red Lead	160 lb.
Bicarbonate of Soda	40 lb.
Refined Ashes	50 lb.
Nitrate of Potash	10 lb.
Arsenic	1 lb.
Manganese	12 oz.

No. 65. Common Dutch:

Sand	300 lb.
Red Lead	160 lb.
Bicarbonate of Soda	70 lb.
Refined Ashes	25 lb.
Nitrate of Soda	25 lb.
Chalk	25 lb.
Arsenic	8 oz.
Blue Manganese	14 oz.
Manganese, pure	6 oz.

Two types of manganese are mentioned in this batch. In Dana's "Minerology" a statement is made that Pyrolusite sometimes has a blue color. This is probably what is meant by "blue manganese." It is interesting that in a batch entitled "Common Dutch" a crude mineral like Pyrolusite should be used with pure manganese dioxide.

No. 66. Best French Flints:

Sand	300 lb.
Red Lead	180 lb.
Refined Ashes	80 lb.
Nitrate of Potash	25 lb.
Borax	10 lb.
Arsenic	1 lb.
Manganese	6 oz.

This batch should be better than No. 48 on account of its higher red lead content, lower alkali, higher nitrate, and higher borax content.

No. 67. Ordinary French:

Sand	300 lb.
Red Lead	100 lb.
Bicarbonate of Soda	75 lb.
Refined Ashes	20 lb.
Nitrate of Soda	25 lb.
Chalk	25 lb.
Arsenic	8 oz.
Blue Manganese	15 oz.
Manganese, pure	8 oz.

This and the two ensuing batches again contain "blue manganese."

No. 68. Flints without Lead:

Sand	270 lb.
Soda Ash, 52 deg.	85 lb.
Chalk	90 lb.
Nitrate of Soda	8 lb.
Arsenic	1 lb.
Blue Manganese	1 lb.
Manganese, pure	12 oz.

Note the title "French without Lead" instead of lime glass or crown glass.

No. 69. Demi crystal Falluysthal:

Sand	300 lb.
Soda Ash, 52 degrees	100 lb.
Chalk	80 lb.
Nitrate of Soda	10 lb.
Blue Manganese	12 oz.
Pure Manganese	1 lb. 4 oz.
Arsenic	8 oz.

The meaning of "demi crystal" is uncertain.

This concludes the records on crystal glasses. The next installment will cover opal and alabaster glasses.

[4] Alexander Silverman, "Importance of Analysis in Purchasing Raw Materials for the Glass Industry," J. Am. Ceram. Soc. 3, 26 (1920).
[5] Robert H. Dalton, U. S. Patent No. 2,009,763 (July 30, 1935).

GERMAN GLASS SHOWS STRONG RECOVERY

THE GERMAN glass industry has put forth an earnest effort this year[1] to increase its volume of export sales with a resultant 25 per cent increase in tonnage for the period January-September, 1935, over the same period of 1934. The increase in value was 10 per cent.

Window glass was the most successful division involved in the increased export trade. Against 13,810 tons worth 2,483,000 marks exported during the first nine months of 1934, this year's exports for the same period totaled 21,211 tons valued at 3,276,000 marks. The principal markets were Great Britain, 4,389 tons; Denmark, 2,857 tons; and Brazil, 2,259 tons.

Exports of plate glass increased from 4,267 tons valued at 3,255,000 marks for the first nine months of 1934 to a tonnage of 5,249 and a value of 3,810,000 marks for the corresponding nine months of 1935. The principal markets for German plate glass were again Great Britain with 1,550 tons, followed by Argentina with 541 tons.

Bottles, glass containers, table glassware, etc., have also made a good showing, especially the class of bottles and vials which advanced to a volume of 6,921 tons from 5,758 tons for the first nine months of 1934, and from 3,145,000 marks to 3,417,000 marks.

It is stated that German exports of glass and glassware have averaged 7,367 tons a month this year and have furnished an outlet for 300 tons per working day.

The German domestic requirements for rough and rolled plate glass, especially wire and fluted, have been expanding steadily in 1935 owing to a very lively building and construction activity. Most plate glass manufacturers are so busy that they require four weeks time to fill the incoming orders. Sales of rough plate glass have increased 20 per cent since the spring of 1935 and 150 per cent against the year 1932. The rate of operation in the German plate glass industry is said to be 70 per cent of capacity.

A decree has just been issued by the Reich Minister of National Economy prohibiting establishment of new plants for the improvement of flat glass or extension of the production capacity in the existing plants of this kind. The decree is to remain in force until December 31, 1936. The prohibition covers reopening inactive plants if they have been closed for more than 12 months. It does not apply to the polishing, grinding and decorating activities of plants which produce their own glass, but affects solely the large industrial group consisting mostly of small shops, devoted to finishing purchased flat glass. In 1933, the date of last industrial census, there were 1,103 establishments of this class employing 7,507 persons.

The scope of the flat glass improving industry is defined as follows: grinding and polishing flat glass; trimming the edges by polishing, grinding, beveling, etc.; drilling holes, cutting finger holds, rounding the corners, surfacing with silver or other metals, bending, etching, sandblasting, decorating with colors and by cutting designs in flat glass.

[1]Notes compiled by the American Consulate, Frankfort-on-Main, Germany, and released through the courtesy of the Specialties Division of the Bureau of Foreign and Domestic Commerce.

Until 1924 plate glass was produced in Germany by the old-fashioned one-table method. Since then most German plants have introduced the Bicheroux process of continuous pouring.

The Bicheroux method is a rolling rather than a casting operation and has resulted in great saving of labor and greater uniformity of output. A tipping pot is made to discharge its content of molten glass against a pair of rolls adjusted so as to leave a slit corresponding to the desired thickness of the glass. The endless band of glass slides over a shute to a traveling table which rolls away at the same rate as the glass band until a certain length has been reached. Then the band is cut off. The separated slab of glass travels on to the annealing furnace whereas the end of the band is taken up by another table until the whole content of the pot has been poured out producing a number of slabs corresponding to the capacity of the pot and the thickness of the glass.

In comparison with the old pouring system, the Bicheroux process permits a quieter pouring, better control of the thickness of glass (within 0.3 millimeter) and eliminates entirely the cooling cracks. It has been adopted by six German plate glass concerns, as follows: Herzogenrather Glassworks; Spiegelmanufactur Waldhof A.G., Mannheim; Germania A.G., Porz-Urbach, bei Koln; Spiegelglasfabrik Reisholz, A.G.; Stolberg Werk of St. Gobain; Rheinische Spiegelglasfabrik. It is also operated by one Belgian company, one British, one Spanish, one Italian, two American, and one Canadian.

The effects of the introduction of Bicheroux process, as reported by one large concern, were the increase of rough plate glass production by 200 per cent and the reduction of cost of labor per square meter of glass by 50 per cent within the first four years after adoption of the new process.

In methods of cooling, an important improvement was effected by abandoning of the old zigzag annealing furnace and introducing the straight furnace also invented by Bicheroux of the Herzogenrather Glassworks. In the zigzag furnace the glass took 2.25 to 4.5 hours to cool; in the modern straight furnace, one hour. The zigzag furnace itself had represented a tremendous improvement over the still older one-chamber annealing furnace which required 20 to 25 hours time to reduce the temperature of the glass down to the safe figure.

The grinding and polishing of plate glass on a round stationary table with revolving grinders and abrasives of various degrees of fineness being applied successively until the plate was removed with one side completely finished has been largely superseded by what is called "band grinding." In this continuous system the grinding tools remain stationary except for the rotary motion whereas plates of glass mounted on rolling square tables pass under the grinding machinery of the successive stages. Each plate comes out ready ground and polished at the end of its trip and is turned over to have the other side ground by the same speedy and efficient process.

In addition to a saving of time and labor the practice of filling the sectors of the round table with smaller pieces of glass has been done away with. As such pieces could only be disposed of at very low prices, they were

a source of unavoidable loss. It is stated that the saving on labor expense in a plant producing annually 400,000 square meters of plate glass is 18.8 per cent by the new grinding process as against the old.

GERMAN SYMPOSIUM ON GLASS

The German Society of Glass Technology (Deutsche Glastechnische Gesellschaft), held its nineteenth symposium on glass technology at Frankfort, January 14-16. The first day's session took the form of a memorial to Otto Schott, and the principal address on the work of this great technologist was given by Dr. G. Keppeler.

On the same day a technical session was held at which the five following papers were presented: "Chemistry of Glass," by Dr. K. Scheel; "Heat Economy and Furnace Construction," by Dir. F. Weckerle; "The Working of Glass," by Dr. A. Wendler; "Glass Decoration," by Professor W. von Eiff; "Methods of Study and Research," by Dr. K. Quasebart.

On the 15th, the business meeting took place followed by another technical session covering in particular research in colleges, technical schools, and factories.

At the last day's session a number of technical papers were presented: "Selenium as a Decolorizer," by Dr. A. Dietzel; "The Problem of the Surface Area Presented by Crushed Glass," by Dr. E. Berger; "Modern Applications of Glass in Building," by Dr. J. Polivka; "The Patent Situation," by Dr. F. Herzfeld; "Fundamentals of Chemical Attack," by Dr. W. Geffken; "Application of Enamels and Colored Fluxes," by Dr. H. Kohl; "The Application of X-rays to the Study of Glasses," by Professor E. Schiebold; "Density and Viscosity in the Soda-Silica System," by Dr. G. Heidkamp and Professor K. Endell; "Study of Transparency of Glass as Dependent upon Temperature," by Dr. A. Klemm.

The above well-rounded program is an indication of the intensity with which the study of glass technology is being carried on in Germany at the present time. We hope to be able to present in review some of the more interesting papers after their publication in *The Berichte.*

The Central Glass Co., has been organized in Shanghai to develop the domestic production of laboratory glassware and hard glass for scientific purposes. However, laboratory porcelain is still largely imported.

GERMANS TO MAKE FIBROUS GLASS

Fibrous glass will soon be made in Dusseldorf, Germany, on American machinery. Owens-Illinois Glass Co. has granted licenses to unnamed German glass makers, and is now shipping two of its machines to Dusseldorf. One of the machines will be used to make fibrous glass and the other for thread to be used for textile purposes.

It is interesting to note that the first fibrous glass ever made was produced in Europe. The European fibrous glass weighed six pounds per cu-ft. as against our present one and one-half pounds. The European method was to assemble it on a revolving steel drum, after heating glass rods to stretch them into small filaments; while the American method, though a carefully guarded secret in its essentials, produces thousands of feet per minute.

NEW PROCESSES HURT BELGIAN GLASS

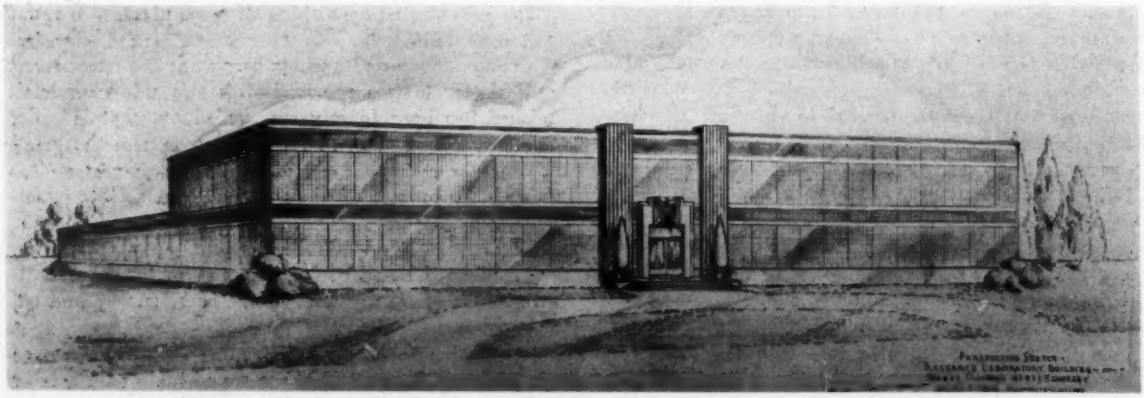
A fatal blow was given the Belgian window glass industry by the discovery of two processes of mechanical manufacture, according to a recent issue of *Industrial and Engineering Chemistry.* They have enabled countries which formerly imported glass to become producers and even, in certain cases, exporters. The production of window glass fell from 37,607,000 square meters in 1930 to 20,270,000 in 1933. In 1934, 16 factories were closed and the number employed dropped from 8,500 to 3,500 working on a four-day week.

The plate glass industry, thanks to a powerful international cartel, was better able to withstand the effects of the world-wide business depression. Exports in 1930 were 39,800 tons, which fell to 27,000 in 1932. In 1934, however, there was an increase to 29,165 tons.

As reported in the December issue of The GLASS INDUSTRY, there was an increase in Belgian glass container exports from a value of 4,897,000 francs in 1933 to 5,991,000 francs in 1934.

FIRST TURKISH BOTTLE FACTORY

Turkey's first glass bottle factory at Pasabadje, was recently opened with solemn ceremonies by Prime Minister Ismet Inoenue. The Minister of Commerce, C. Bayar, prophesied in an address that the factory would soon make Turkey independent of bottle imports.



Architects drawing of the first all-glass windowless building which will be in operation Feb. 1. The packaging research laboratories of the Owens-Illinois Glass will be housed here.

H. V. BRUMLEY DIES

With deep sorrow The GLASS INDUSTRY records the death of Howard Viele Brumley, secretary of the Whitall Tatum Co. Mr. Brumley had enjoyed a long and useful career in his chosen work, which dates back to 1890, the year of his graduation from college. During his career of nearly half a century with Whitall Tatum, he climbed steadily from the bottom of the ladder to the secretaryship of the business. Mr. Brumley belonged to many clubs, among them the Union League Club of New York, the Sons of the Revolution, as well as golf and yacht clubs. His widow, two daughters and a son survive him.

PUBLICATIONS RECEIVED

Technical Bulletin. Bulletin No. 61. December 1935. American Refractories Institute, Pittsburgh, Pa.

Part I of a series on the properties of insulating refractories by S. M. Phelps of the refractories fellowship, Mellon Institute of Industrial Research. This fully illustrated publication deals with the behavior of insulating fire brick under loads at high temperatures.

Classification Chart of Typical Coals of the United States. R. I. 3296. Bureau of Mines, Department of Interior, Washington, D. C.

This chart shows the B.T.U. per pound on the moist, mineral-matter-free basis, plotted against fixed carbon on the dry, mineral-matter-free basis.

Foote-Prints on Chemicals, Metals, Alloys and Ores. Vol. 8, No. 2, Dec. 1935. Foote Mineral Co., Philadelphia.

Contains an extremely interesting article by Dr. F. Russell Bichowsky on the use of lithium chloride for air conditioning. Dr. Bichowsky is the inventor of the system described and lists the advantages of this extremely hygroscopic material which has made possible a new system of air conditioning.

O-I CHOOSES DAVIS TO PUSH INDUSTRIAL GLASS

Owens-Illinois Glass Co. has announced the appointment of William C. Davis as director of merchandising for its Industrial Materials and Structural Materials Division. Mr. Davis comes to the Owens organization with a splendid sales and engineering background in the construction industry, and his acquisition is regarded as significant of the aggressive role Owens intends to assume in this field, as well as of the extended use glass is expected to have as a building material.

Fibrous glass as an insulating material and glass blocks for structural purposes have advanced well beyond the laboratory stage. The latter months of 1935 found the country at large not only interested in the use of glass for such purposes, but actually using these materials extensively. Demand having therefore reached an important volume stage, Owens-Illinois saw the need to build an organization of men with long experience in the construction field.

Mr. Davis has announced a three-fold policy: "We will merchandise and sell glass blocks through building material dealers; we will manufacture a quality product to be sold at points well located to give complete and adequate distribution; and we will support sales through dealers with a consistent and adequate merchandising plan, reaching architects, contractors and consumers."

HONORS BAUSCH & LOMB EXECUTIVE

Carl L. Bausch, Vice President, Bausch & Lomb Optical Company, has been invited to become a member of the new National Advisory Council on Applied Physics. This new advisory body, sponsored by The American Institute of Physics, will have the cooperation of a number of scientific societies and large corporations in an effort to stimulate the practical application of physics in science and industry.

Much that is heard about modern physics, the report reads, deals with relativity, quantum mechanics and other erudite aspects of science, and while these subjects have practical significance their emphasis diverts attention from the immediate practical resourcefulness of the modern physicist. It is forgotten that his vacuum technique is applied to lamps, radio tubes and even coffee containers; that his knowledge of electrical and mechanical vibrations is applied to the recording and reproduction of sound in the movies; his X-rays, to finding flaws in existing metals and designing new alloys; his electrical discharges, to sodium and neon lights; and his most delicate instruments, to the detection of oil and other mineral deposits.

Future applications of physics may be expected in almost every industry. Physical principles will, for example, enter into the development of economical railway trains, pre-fabricated houses, air-conditioning plants, the preservation of food, the processing of plastics, color in photography, television, and many other important applications not yet foreseen.

Carl L. Bausch, director of Bausch & Lomb research.

GLASS CONTAINER PRODUCTION INCREASES

Figures recently released by the Glass Container Association indicate that the 1935 production of bottles is 7½ per cent greater than the 1934 level. Included in this calculation are food containers, fruit jars, milk and beer bottles, liquor ware, medicine bottles, etc., totaling 37,652,423 gross as compared to 35,035,635 in 1934.

There was a large increase in beer bottle production. November statistics show that not only did the consumption of bottled beer increase 31 per cent for the first 11 months of 1935 over the same period of the previous year, but also that the production of bottled beer to draft beer was up 4.2 per cent. Thus, the sale of bottled beer appears to be on the increase and manufacturers are laying plans for the production of 1,600,000 gross, or 230,400,000 bottles in 1936. Production in 1935 was 171,147,744 bottles which is an increase of approximately two per cent over the previous year. Added stimulus has been given this branch of the bottle business by the introduction of two new types of bottles, the Stubby and the Steinie.

Milk bottle production in 1935 was up ten per cent over the 1934 level. This field presents a peculiar problem in that the life of a milk bottle varies considerably in different localities, ranging from 15 to 20 trips in Pittsburgh to as high as 90 in Boston. Thus milk bottle costs vary from half a cent to as little as a twentieth of a cent. Obviously, the longer a bottle continues in service, the fewer glass manufacturers have to produce. The G. C. A. points out, however, that the country-wide production is below normal and that it is expected to show further substantial gains in 1936.

Because liquor bottles must be destroyed immediately after emptying, an entirely different picture is presented here. Varieties in design and other factors play a large part in this division of the industry. Federal economists foresee a nine per cent increase in liquor consumption during the coming year.

PLATE GLASS PRODUCTION BEATS RECORD

The Plate Glass Manufacturers Association announces that the total production of its member companies in December was 16,112,218 square feet as compared to 15,909,262 square feet produced in the preceding month, November. This brings the 1935 total to 179,816,459 square feet as compared to 94,566,978 in 1934. This surpasses the record year 1929, when 150,498,287 square feet were produced.

OWENS TO MAKE CANS

Owens-Illinois Glass Co. recently announced the purchase of two tin can manufacturing plants, the Enterprise Can Co., Pittsburgh, and the Tin Decorating Company of Baltimore. The new acquisitions will be operated by the Owens-Illinois Can Co., to be organized, which will have as president Fred A. Prahl, until recently vice-president of Continental Can. The company denies any intention, for the present at least, of manufacturing beer cans, but states that it will supply general line cans and packers sanitary cans. The move is in line with the general Owens Policy of furnishing a complete packaging service, and the tin can simply adds to the glass, paper and wood containers already being made available. Tin Decorating Co. has also been a factor in the metal cap industry for a number of years.

L-O-F EARNINGS SOAR

Net earnings of the Libbey-Owens-Ford Glass Co. for the calendar year of 1935, after depreciation, taxes and other charges, were $8,167,419.79, equal to $3.26 per share, compared with $3,161,831.54 or $1.24 per share in 1934, it was announced at the meeting of directors here. This improvement is attributed to substantially increased sales of all products, which has enabled the company to operate steadily throughout the year.

In addition to maintaining all plants at high standard of operating efficiency, several expansions were made and new products acquired through acquisition of other companies. Expansions include: New safety glass plant at Ottawa, Ill., which commenced operations in December; new warehouse at the East Toledo safety glass plant; new warehouse, box shop and office at the East Toledo plate glass plant. The Vitrolite Company, manufacturer of structural glass at Parkersburg, W. Va., was purchased during 1935.

Included among the company's products are: Colored plate glass (in blue, green and peach); "Invisible" plate glass, through a licensing arrangement with the Invisible Glass Co. of America; Thermopane, a double glazed glass; and Tuf-Flex, a new tempered glass.

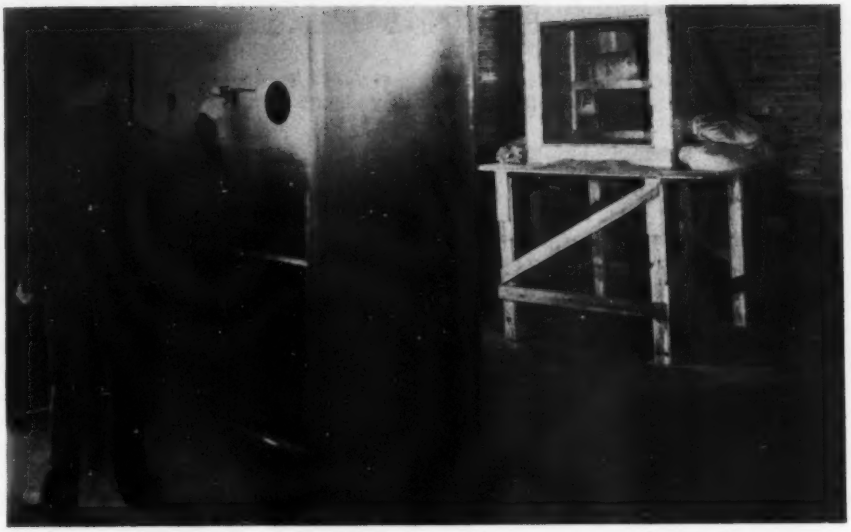
Libbey-Owens-Ford states that its federal, state, county and city taxes exceeded $1,700,000 in 1935, a sum equal approximately to 70 cents of each of the Company's outstanding shares.

FORD INVITES GLASS FURNACE TENDERS

Tenders have been invited by the Ford Motor Company for construction of a continuous glass melting furnace to be installed in the safety glass factory at the Rouge Plant, Dearborn, Mich. The furnace will cost in the neighborhood of half a million dollars and will increase the capacity of the plant from 75,000 to 200,000 square feet of rough plate glass per day. Foundations are already in place. This is the last major equipment order in the glass factory enlargement, which has been in progress since last March at an estimated total cost of $3,000,000.

Lacking, for the present, grinding and polishing facilities, the Rouge glass plant for weeks past has been rolling rough plate glass against stock, so as to have it available for the new grinding and polishing machinery now being installed. Already some 5,000,000 square feet has accumulated, and will continue to accumulate until February when the grinding and polishing units will be completed. This new grinding line will be more than double the capacity of the existing furnace, which is similar to the one formerly used at the Highland Park plant, where plate glass was first made by the continuous process. The new furnace will, therefore, coordinate production of rough plate glass with finished safety glass. It is expected to be in operation about June 1.

CHEMIST, with fifteen years' experience in Glass Manufacturing, desires position either as Plant Chemist, or as Consultant. Fully qualified to produce Flint, Opal, and all types of Colored Glasses in Pot or Tank Furnaces. Address The GLASS INDUSTRY, Box 26, New York City.



A practical test to make sure bullet-proof glass is bullet-proof.

KEEPING SAFETY GLASS SAFE

The efforts of the Underwriters' Laboratories in Chicago to keep safety glass safe will be of more than passing interest to glass manufacturers. These laboratories were established in 1901 by some 200 insurance companies on a non-profit basis to obtain unbiased facts about products affecting their business. It is their function to know why bullet resistant glass is resistant and why fire windows in factory walls actually perform as promised. More than 1300 varieties and classifications of products and safety systems are scientifically tested by these fact-finders.

To test bullet proof glass, it is logical to submit the glass to just such a barrage of gun fire as it might be called on to resist in dead earnest some day. As the investigator prepares for this he spreads out on a table before him an assortment of the most powerful small arms commonly employed by bandits. Super-automatics they are, some of .38 caliber and others up to .45.

At one end of the room a sample of the glass has been set up in a frame. Previous examination and tests have determined how firmly the layers of plastic substance in the composite product will resist moisture and heat. If the laminations should fall apart in the 120° heat of an Arizona bank or the moist air of a semi-tropical town, the glass would be valueless at the crucial moment. These preliminary tests have therefore satisfied the laboratory folks that the bonding substance is up to the required standard. Tests for uniformity of thickness, for visibility and other physical characteristics have also been completed and now the final firing test begins.

A few feet from the frame holding the glass rises a barrier of armorplate with loop holes for gun fire. This is to serve as a shield when bullets rebound from the glass. One by one the revolvers of different caliber are discharged point blank at the glass and the effect of each shot is carefully determined with reference to the standards demanded.

Again the test calls for discharge of several bullets so aimed that they strike in an area a few inches apart, to see if large particles might be forcibly thrown from the rear laminations. This, of course, might be as bad for a bank cashier as a bullet itself. Then come the tests with sub-machine guns and with high-powered rifles.

If the product fails to pass the tests it is returned to the manufacturer who then seeks to overcome the defects noted in the Laboratories' detailed report. Redesigned and reconstructed samples are often submitted several times and not until the performance measures up to the required standard is the investigation ended. Then, and not before then, the bullet-proof glass gets the label for which all this work has been done.

In the fire protection department of this Chicago laboratory the glass industry has other important contact through the tests of fire windows glazed with wired glass. In the "furnace room" during a test, there is a travelling crane from which is suspended a frame made of steel girders such as go into a modern skyscraper or factory wall. This frame swings free from the floor and within it the fire window is set and bricked up exactly as it would be in a finished structure.

When all is ready, the crane swings this ponderous load over to form the front side of a "panel furnace," rising on the floor close by. Built of fire brick, it is some fifteen feet long and rises fifteen feet like a garden wall. It is some two feet thick with its one face entirely missing. Through the side opposite this opening scores of gas jets, controlled by valves in the rear of the structure project. There is an arrangement for pumping in air at the base.

When the segment of wall held by the crane is properly located to form the missing face of the furnace, it is cemented air-tight to the rest of the structure and the gas is ignited within the cavity to form a "standard fire." For 45 minutes the flames lick at the fire window. Then the gas is turned off and a stream of water under 35 pounds pressure is trained on the cherry-red glass from a distance of 20 feet. When things cool off a bit, examination of the results shows how safe the safety glass may be.

The proper height of work, whether standing or sitting, should be about two inches below the height of the operator, according to the National School of Time Study.

EQUIPMENT AND SUPPLIES

LABORATORY FOR PETROGRAPHIC ANALYSIS

Bailey and Sharp Co., Hamburg, N. Y., has announced the availability to the ceramic industry of commercial laboratory facilities for accurate identification of stones in glass for the study of crystals, and for general petrographic analysis of vitreous materials.

A. K. Lyle and Wm. Horak, each thoroughly experienced in such work are in charge of this department. James Bailey, who for a period of years was the active supervisor of the pot and clay department of the Corning Glass Works, will work with them.

The laboratory equipment includes microscopes of several different types, means for preparing thin sections and polished specimens, and a variety of accessories, special objectives, illuminators and quartz wedges of different types. An extensive library of slides of ceramic petrographic specimens has been built up over a period of years, and facilitates interpretation of the true source of such defects as stones in glass.

Announcement is made by Link-Belt Co. that in order to handle increasing business they have moved their district sales office in St. Louis, Mo., from 3638 Olive St. to 1018-21 Louderman Building, 317 N. 11th St. Larger quarters are thus provided in the heart of St. Louis business district. Howard L. Purdon is district sales manager.

BAILEY DRAFT CONTROLLER

A complete self-contained furnace draft controller requiring only a draft connection to the furnace and a supply of compressed air at approximately 35 lbs. pressure has been developed by Bailey Meter Company, Cleveland, Ohio.

This controller accurately measures furnace draft with a large sensitive diaphragm, the movement of which actuates an air pilot valve admitting pressure to one end or the other of a drive cylinder until the damper position or fan speed has been changed sufficiently to restore furnace draft to the desired value.

For pressure and temperature control applications not requiring a record of the factor under control, the Bailey Meter Company has also developed an Indicator-Controller which may operate either a diaphragm motor valve or an air-operated control drive. This incorporates an indicating pointer and scale graduated to measure the factor under control. A second pointer indicates the standard for which the controller is set so that the two pointers coincide when the controller is in operation. The standard setting may be changed to any desired point by turning a knurled knob located under the indicating dial.

CATALOGS RECEIVED

Herringbone-Gear Speed Reducers. No. 1519. Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia. Describes its line of single, double and triple reduction reducers for large speed ratios and heavy and shock loads. All reducers are rated on the basis of the recommended practice of the American Gear Manufacturers Association.

Duplex Compressors. Bulletin No. 3162. Ingersoll-Rand Co., 111 Broadway, New York City. An attractively and profusely illustrated 36-page booklet presenting a line of power-driven, horizontal duplex, double-acting, cross-head type, moderate speed, heavy duty compressors. Both direct motor-driven and belt-driven units are treated.

Save-Lite. Sherwin-Williams Co., Cleveland, Ohio. An analysis of conditions telling what a paint should do for specific plant layouts. Also given are reflection values of different paints and photographs illustrating case histories.

Apparatus for Testing Petroleum Products. Catalog 160. Precision Scientific Co., Chicago, Ill. An 80-page publication compiled alphabetically for quick reference work. Contains detailed specifications and references to American Society of Testing Materials standards.

Micromax Smoke-Density Recorders. Catalog N-93, 1936. Leeds & Northrup Co., Philadelphia, Pa. An amply illustrated 16-page catalog describing electrical equipment for measuring smoke density at the stack and recording changes.

G-E REDESIGNS AF-1 CIRCUIT BREAKER

The Type AF-1 air circuit breaker of the General Electric Company, which replaces fuses and which is designed for the control and protection of industrial circuits, house service entrance, branch circuits, refrigerators, ranges, etc., has been redesigned to provide a "mid-position" of the handle to indicate automatic tripping.

Upon automatic tripping, the handle now assumes a position between the "on" and "off" positions. This feature solves the problem of automatic trip indication when the breaker is mounted in an enclosed case. Reclosing of the breaker is easily accomplished by moving the handle to the extreme "off" position. It is then ready for closing.

AMERICAN FOUNDRY MODERNIZES

Vast increase in business caused by demand for the "Wheelabrator" airless abrasive cleaning equipment, has made necessary the modernization of the entire plant of the American Foundry Equipment Company, Mishawaka, Indiana. A large new building for assembly and shipping has also been added and the foundry improved. Besides the Wheelabrator, the company also manufactures sand cutters, dust collectors, pouring jackets, core machines and other abrasive blast equipment.

The Harnischfeger Corporation, Milwaukee, announces the appointment of of R. L. Mead as manager of the Chicago office, 20 North Wacker Drive. The Company's products include materials handling brewery equipment.

CYANAMID'S TECHNICAL DIRECTOR

Dr. Norman A. Shepard has been appointed director of technical service for the American Cyanamid Co., New York, and other companies in the cyanamid group. He will direct the technical laboratories in Stamford, Conn., and will expand the sales service laboratories to meet present and future needs, as well as co-ordinate the technical and sales work.

PRICE OF GLASS SAND

The average price of glass sand for the year 1934 was $1.73 per short ton, according to the Minerals Year Book of the Department of the Interior. The total production of glass sand for the United States was 1,923,614 short tons. Leading producing areas are: West Virginia, Pennsylvania, Illinois, California, New Jersey and Missouri, in the order named. Importations for the year in question totaled 24,516 tons.

Westinghouse Electric & Manufacturing Co. is celebrating its 50th year as a contributor to the industrial development of the United States. On Jan. 8, 1886, the pioneer work of Geeorge Westinghouse in the electrical field was coordinated into corporate form under a charter granted by Pennsylvania. From the days when it constructed the first steam turbine in America and harnessed Niagara Falls, the company has progressed until today there is scarcely an industry that is not serviced by Westinghouse.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 130 lb. carboy ext.	Per 100 lb.	...	5.50
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	.. | Po. or Gr. | Cry.	.25 .25½
Aluminum hydrate (Al $(OH)_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium bicarbonate (f.o.b. works)	lb.	.0515	...
(f.o.b. N. Y.)	lb.	...	.0571
Ammonium bifluoride (NH_4FHF)	lb.	...	.14½
Ammonium nitrate (NH_4NO_3)	lb.	...	.08
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¾
Antimonate of Sodium	lb.	...	.13¾-.14½
Antimony oxide (Sb_2O_3)	lb.	...	.13¾
Antimony sulphide (Sb_2S_3)	lb.	...	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04-.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
90% through 100 mesh	ton	37.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.049	.05½
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¾
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.022	.0245-.027
Powdered	In bags, lb.	.0245	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.05	.0525-.055
Cadmium sulphide (CdS)—	lb.	...	1.00-1.10
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Chromite	lb.	...	.0215
Cerium hydrate 100 lb. drums and 600 lb. barrels	lb.	...	.65
Chrome Oxide Green, 400 lb. bbls.	lb.	.17	.215-.25
Cobalt oxide (Co_2O_3) In bbls.	lb	...	1.29
In 10 lb. tins	lb.	...	1.39
Copper oxide Red (Cu_2O)	lb.	...	.20
Black (CuO)	lb.	...	.15
Black prepared	lb.	..	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08	.08½
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	2.30
Feldspar— 20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2 2½%) Bulk, carloads, f. o. b. mines	ton	31.50	...
In bags	ton	33.10	38.00-40.60
Formaldehyde, bbls.	lb.	...	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide— Red (Fe_2O_3)	lb.	...	.0425
Black ($Fe3O_4$)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	8.00-9.00	...
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.16
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.07	...
In 5 Ton lots	lb.	..	.075
Less than 5 Tons	lb.	...	08

		Carlots	Less Carlots
Lime— Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Limestone ($CaCO_3$)	ton	1.75	...
Litharge (PbO) (New York Prices)	lb.	.06	...
In 5 Ton lots	lb.	...	.065
Less than 5 Tons	lb.	...	.07
Magnesium carbonate ($MgCO_3$)	lb.	.06	.08-.09
Magnesium sulphate (U.S.P.)	lb.	...	.0265
Manganese, Black Oxide In Paper bags	ton	50.00	52.50-55.00
In Burlap bags	ton	51.50	54.00-56.50
In Casks	ton	53.00	55.50-58.00
Neodymidm oxalate, 50 lb. drums	lb.	...	5.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb.	...	.09
Powdered	lb.	...	.09½
Potassium carbonate Calcined (K_2CO_3) 96-98%	lb.	.06⅞	.07⅛
Hydrated 80-85%	lb.	.06	.06¼-.06⅜
Potassium chromate (K_2CrO_4) 450 lb. bbls.	lb.	...	.16
Potassium hydrate (KOH) (caustic potash)	lb.	.06¼-.06½	.08-.08½
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	...	.19
Powder blue	lb.	...	.20
Rare earth hydrate 100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Rochelle salts, bbls.	lb.	...	.12½
Rouge	lb.	... | Po. or Gr. | Cry.	.13½
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Silver nitrate ($AgNO_3$) . (100 oz. bot.)	per oz.	...	.39
Soda ash (Na_2CO_3) dense, 58%— Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.07
Sodium chromate ($Na_2CrO_4 10H_2O$)	lb.	...	.08¾
Sodium fluosilicate (Na_2SiF_6)	lb.	.05¼	.05¾
Sodium hydrate (NaOH) (caustic soda) Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$)— Refined (gran.) in bbls.	Per 100 lb.	...	2.00-2.25
95% and 97% Bulk	Per 100 lb.	1.175	...
200 lb bags		1.24	1.29
100 lb. bags		1.275	1.325
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.		1.50-1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)— Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.35½
Tin oxide (SnO_2) in bbls.	lb.	...	.51
Uranium oxide (UO_2) (black, 95% U_3O_8) 100 lb. lots. Black	lb.	...	3.00
Yellow orange	lb.	...	1.50
Zinc oxide (ZnO) American process, Bags	lb.	.05	.05¼
White Seal, 150 lb. bbls.	lb.	.06¾	.07
Green Seal bags	lb.	.06	.06¼
Red Seal, bags	lb.	.05½	.05¾
Zircon Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude. Gran. (Milled .005-.02c higher)		.03½	.04-.05

DETERMINATION OF ALKALIES IN FELDSPARS

OF SPECIAL INTEREST to glass chemists is a new modification of the Berzelius method for the disintegration of a silicate preliminary to the isolation of the alkali metals as chlorides. The procedure has recently been described by Koenig[1] who successfully used it in the analysis of feldspar. Its possibilities in the field of glass and glass-making materials are reported as encouraging. The procedure is as follows:

Procedure. Transfer 0.5 gram of the 150-mesh sample (previously dried at 110°C.) to a 75-ml. platinum dish (a dish of the Payne type is particularly suitable) and moisten with water. Add an excess (10 ml. is sufficient) of hydrofluoric acid and evaporate the solution to dryness on the water bath. Take up the residue with water (complete solution is unnecessary) and transfer to a 100-ml. beaker, to which approximately 2.5 grams of purified calcium oxide have been added. Police and rinse the dish, adding the washings to the beaker. Stir, and after boiling briskly for 5 minutes, filter through a retentive paper, catching the filtrate in a 300-ml. porcelain casserole or platinum dish. Police the beaker and add the rinsings to the filter. Wash the precipitated hydroxides and fluorides several times with boiling water and discard the residue.

Add 25 ml. of ammonium carbonate solution to the filtrate and evaporate to dryness. Take up in a minimum of water, add 15 ml. of the ammonium carbonate solution, and allow to digest for 15 minutes. Fifter through a retentive paper, catching the filtrate in a 100-ml. beaker. Wash the residue sparingly with cold water and discard.

Treat the filtrate with 4 drops of ammonium oxalate and digest, while uncovered, at a temperature just below the boiling point for 1 hour. The solution is now reduced in volume to about 50 ml.

Filter through a tight paper, catching the filtrate in an untared platinum dish, and wash the residue well, but sparingly, with a 1 per cent solution of ammonium oxalate. Discard the residue and after treatment with an excess of hydrochloric acid (to convert carbonates to chlorides), evaporate the filtrate to dryness on the water bath.

The ammonium salts are completely volatilized at a low temperature (below dull redness) and the salts just melted. Dissolve the residue in a minimum of water and filter through a small paper, catching the filtrate in a tared platinum dish. Wash the residue sparingly with cold water and discard. Add a few drops of hydrochloric acid to the filtrate to convert any alkali carbonates to chlorides and repeat the evaporation. Just melt the salts over a very low flame and desiccate over an active desiccant. Weigh rapidly (alkali chlorides are relatively hygroscopic) and record as total alkali chlorides. Reserve the residue for the determination of sodium and potassium.

The nonvolatile matter removed by filtration after the first volatilization of the ammonium salts is of no great consequence, amounting to only 0.7 mg. (= 0.4 mg.). In any but the most exacting analysis this step in the procedure can be eliminated entirely by weighing the total alkali chlorides plus nonvolatile matter and correcting for the latter.

[1]Ind. Eng. Chem. Anal. Ed. Vol. 7, No. 5, P. 314.

INDEX OF REFRACTION OF SOME POTASH-SILICA GLASSES

From the *Technical News Bulletin*, National Bureau of Standards.

Continuing the Bureau's work on the relation between certain properties and the composition of glass, 86 glasses of the potash-silica series were made, annealed, analyzed, and the index of refraction measured. The composition of the glasses ranged from approximately 15 to 40 percent potash, silica being the only other constituent present. They were made from the purest obtainable potassium carbonate and powdered quartz and were melted in platinum.

The index of refraction (for sodium light) changed from 1.5019 at 37 percent potash to 1.4804 at 17 percent. Although the actual refractivities of the potash-silica glasses are less than those of the corresponding soda-silica glasses (1.5076 and 1.4851) by approximately 0.005, it is interesting to note that the total change in each series is approximately the same (0.022).

If the refractivities of the potash glasses are plotted against their potash (or silica) content, it seems that the data can be represented by two straight lines intersecting at about 29 percent potash (71 percent silica) better than by a continuous curved line. These two straight lines may be represented by the equations:

$$N=1.4676+0.00092K$$
$$N=1.4603+0.00118K'$$

in which N is the index of refraction of the glasses, K is a potash content greater than 29, and K' is less than 29 percent.

It must be noted, however, that extrapolation of the $=K'$ equation to 100 percent silica ($K'=0$) gives 1.4603 as the index of refraction of pure vitreous silica, a value 0.0016 greater than the measured value. This suggests another straight line somewhere between 85 and 100 percent silica, or necessitates some curvature in that range. That a straight line might be anticipated is suggested by previous data on the soda-lime-silica glasses (reported in BS J. Research 6, 933 (1931) RP320), because extrapolation to 100 percent silica of the data in that report gives the proper value for the index of refraction of vitreous silica.

A conference of the mineral industries, devoted to a discussion of trends in the utilization of fluorspar, was held at Rosiclare, Illinois, on Jan. 24. C. W. Parmalee, Head of the Department of Ceramic Engineering at the University of Illinois, read a paper on "The Future of Fluorspar in the Ceramic Industry."

A NEW COVER SERIES

One of the most important factors in the manufacture of glass is the accurate measurement of ingredients for the batch. In order to remove the uncertain "human element," automatic weighing is utilized by the Pittsburgh Plate Glass Co. in mixing batches for Pennvernon flat drawn window glass. The front cover illustration for this issue shows this machinery in action, supervised by a skilled craftsman.

This interesting picture is the first of a series of views behind the scenes of a great industrial development and will detail the various steps in the manufacturing of window glass. The GLASS INDUSTRY wishes to express its appreciation to the Pittsburgh Plate Glass Co., for these informative photographs.